SHOUT
SHARE
IT

MVS
4890

HARVARD UNIVERSITY

Library of the
Museum of
Comparative Zoology

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
VOL. LXXX, No. 1

THE MILLIPEDS OF HISPANIOLA, WITH DESCRIPTIONS OF A NEW FAMILY, NEW GENERA, AND NEW SPECIES

BY H. F. LOOMIS
Bureau of Plant Industry
U. S. Department of Agriculture

WITH THREE PLATES

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
APRIL, 1936

9774
105

No. 1. — *The Millipeds of Hispaniola, with descriptions of a New Family, New Genera, and New Species*

By H. F. Loomis

INTRODUCTION.

No truly comprehensive collection of millipeds ever has been made in the island of Hispaniola, nor has the island been investigated by collectors primarily interested in these creatures, and consequently the milliped fauna is very poorly known. Until visited in 1912 by Dr. Wm. M. Mann, no systematic collecting had been done, and only nine species were reported from the entire island. The Mann collection included 31 species, of which 25 were described as new by R. V. Chamberlin,[1] and was made entirely in the Republic of Haiti, centering about Port-au-Prince, with journeys to Jacmel on the south coast, and to Cape Haitien on the north coast.

A large number of millipeds was accumulated by Dr. O. F. Cook and the writer on various trips to the island, extending from 1917 to 1934, nearly all the territory explored being in the Republic of Haiti and not varying greatly from that visited by Dr. Mann, hence much of the terminal portion of the Southern and of the Northern peninsula, and the eastern frontier of the Republic, was not searched for millipeds. This collection and two others from the Museum of Comparative Zoölogy, Cambridge, Massachusetts, form the basis of this paper. Both of these latter collections were of particular interest as the material they contained came mainly from territory not previously collected in and many new forms were included. The first of the collections was made in Haiti and Santo Domingo by Dr. T. Barbour and his family, while guests of Mr. Allison V. Armour on his Research Yacht "Utowana," from March to May, 1934. The second collection came from the mountain ranges of La Selle and La Hotte in Southern Haiti, and was made by Dr. P. J. Darlington in the autumn of 1934.

The rather definite localization of the species, as shown by Dr. Mann's collection and those here studied, gives assurance of a considerable number of additional forms being found in the Republic of Haiti, and since Santo Domingo is almost wholly unexplored, a still greater number of species undoubtedly await discovery there. With these new forms in prospect it may be predicted that the island of Hispaniola probably contains as many or more species of millipeds than any other area of like size, at least in the Western Hemisphere.

[1] Bull. Mus. Comp. Zoöl., **62**, no. 5, pp. 151–262, 1918.

The abundance of milliped species is accounted for when the physical aspects of Hispaniola are considered. High mountains, deep valleys, broad plains, and varying temperatures and rainfall combine to give the island an almost complete range of living conditions of the kind in which humus animals may dwell. Tropical lowlands adjoin arid deserts or grassy plains, and the mountains are in close proximity to all and offer habitats such as are associated with the temperate rather than the tropical zone. Certain sets of favorable environmental conditions may be repeated in separate localities and evolutionary changes in the different localities in time would account for a larger number of species than in a widespread fauna where little or no isolation occurred. Such an explanation seems logical for the relatively numerous species in some of the Hispaniolan genera of millipeds, such as *Prostemmiulus* and *Cyclodesmus*, and doubtless should be extended to include the many indigenous genera.

Because of the varied physiographic characters of Hispaniola, and the abundant humus fauna, interesting studies of the distribution and evolution of the millipeds will become increasingly possible as the systematic work on the group progresses. Few other groups of insects, animals or plants offer similar opportunities for these studies in such a small area as that presented by this island, and from this standpoint it probably is the most important link in the chain of islands extending between South America and the United States.

Among the especially interesting features of the present collection may be mentioned an unusual new family, the *Eoromidae*, erected for a creature with raised, somewhat wing-like lateral carinae, unlike anything previously known in the order to which it belongs.

Species of three genera, *Cyclodesmus*, *Prostemmiulus* and *Microspirobolus*, were found to be remarkably plentiful, and it is certain that many new species await discovery. Such examples indicate the antiquity of the milliped fauna, and the possibility that the island may have been a principal center of distribution to other islands is suggested.

A new species of *Rhinocricus*, the largest ever described, was found on the Southern Peninsula. In collecting this giant milliped, it was discovered to have the unusual ability of ejecting its repugnatorial secretion far from the sides of the body, and on turning up one of the specimens from the forest leaf-litter, the writer was painfully injured by this fluid being shot upward into his face; the first known injury of a serious nature to man by a milliped.

These collections as a whole are remarkable in two major particulars: (1) they more than treble the number of millipeds previously known

from Hispaniola; and (2) it is thought that the 78 species added to the island's fauna were, with one exception, previously unknown to science.[1] In few other branches of the animal kingdom may such a wealth of new material be found, and as the status of the Hispaniolan millipeds is typical of that in many other parts of the world, it well illustrates the great amount of systematic work that must be done before our knowledge of this group is at all comparable to that in most other branches of invertebrate zoölogy.

An interesting comparison may be made between Hispaniola's milliped and butterfly faunas. As previously mentioned, milliped collecting in Hispaniola has but begun, and by far the greatest part of the island remains to be searched. Quite in contrast, the butterflies are well known and surprisingly few in number, as only about 140 species have been reported, and the proportion of undiscovered species is believed to be relatively small. At the present time 113 millipeds are known, and observations on the localized distribution of many of them indicate that when the island has been as thoroughly searched for millipeds as it has been for Lepidoptera, the millipeds probably will decidedly outnumber the butterflies, a remarkable condition indeed, and one not recognized for any other region, so far as the writer knows, although more extensive collecting in Cuba may show a similar condition to exist there.[2]

The present paper is but a beginning toward classifying the millipeds to be found in Hispaniola as so small a part of the island has been searched for these creatures, but to facilitate future work on the group the paper has been written in semi-monographic style, including keys to the orders, families, genera, and species, in addition to the descriptions of the new material. In several cases new descriptions or notes pertaining to previously known species have been included where the original or subsequent descriptions do not allow easy comparisons to be made with related species.

Since practically all the millipeds dealt with in this paper are from the Republic of Haiti, the locality citations in the following pages are understood as referring to that portion of the island, unless the Dominican Republic is specifically mentioned.

Much of the material studied is the property of the United States

[1] In the collection made by O. F. Cook and the writer are several species which first were found in Haiti and later in other West Indian islands by the writer while a member of the A. V. Armour Expedition in 1932. These species were described in the Smithsonian Miscellaneous Collections, **89**, no. 14, 1934, but are here considered as part of the new material added to the Hispaniolan fauna by the collection.

[2] The above information on the butterflies of Hispaniola was given the writer by Dr. Marston Bates, of the Museum of Comparative Zoölogy, Cambridge, Mass.

National Museum and the type specimens in this material are deposited there, but where paratype specimens are available, they have been deposited in the Museum of Comparative Zoölogy. In all other material the type and paratype specimens are deposited in the latter institution.

Class DIPLOPODA

The class *Diplopoda* is divided into two subclasses, of which the first, the *Pselaphognatha*, is characterized by having the body without external chitinous armor, the soft skin being beset with toothed and barbed bristles in definite dense clusters and rows, the clusters especially prominent on the sides and back end of the body; the anus is located in the penultimate segment. In the *Chilognatha* the body is protected by definite chitinous armor, and when bristles are present they are not in dense clusters along the sides or at the back end of the body, and the anus is in the last segment.

Subclass PSELAPHOGNATHA

This subclass contains relatively few species as compared to the *Chilognatha*, in which the majority of millipeds belong. The species are small and very active and are most often found in partly dry leaf-litter or other vegetable debris in protected locations. Because of the ease with which the bristles rub off, the collection and preservation of specimens in a satisfactory condition are difficult matters.

The existing species are included in a single order of which but two species have thus far been recognized in Hispaniola.[1]

Order ANCYROTRICHA

Family POLYXENIDAE

Lophoproctus Pocock

Lophoproctus niveus Loomis

Lophoproctus niveus Loomis, Smithsonian Misc. Coll., **89**, pp. 5, 6, 1934.

The type locality is Beata Island, off the south coast of Hispaniola. Several badly rubbed specimens, appearing to be this species, although slightly darker in color, were collected at Kenscoff, June 24, 1934 by E. M. and H. F. Loomis.

[1] The best method of preserving thus far tried is to place single specimens in tiny glass vials requiring but a few drops of 70 per cent alcohol to completely fill the vial. A tiny cork stopper is inserted in such a way that all air is excluded, so that no active shaking of the specimen takes place, due to movement of air back and forth in the vial during handling or transportation. These tiny vials are stored in larger vials filled with similar alcohol.

Lophoproctus aequatus new species

Four females collected at Petite Riviere de Artibonite, July 6, 1927, C. & L.[1]
Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. This is a smaller, darker species than *L. niveus;* the antennal joints are of different proportions; and the terminal pencil of hairs is smaller and shorter.

Description. Maximum length 2.5 mm., including the terminal pencil of hairs; width .7 mm.

Color darker than in *L. niveus.*

Head with the setae arranged as in *L. comans* and *L. niveus.* Labrum with the median notch small. Antennae with the joints more nearly subequal in length than in the other species. (Fig. 1.)

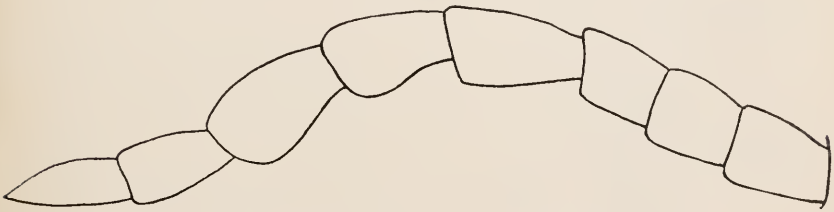


Fig. 1. *Lophoproctus aequatus.* Antenna.

First segment with 2 large, submedian, transversely oval clusters of clavate, barbed setae, and obliquely outward in front of each cluster is a smaller oval area containing equally long hairs close to the anterior margin.

Second segment with the lateral prominence at each anterior corner not noticeable produced forward but projecting nearly straight outward. Vestiture of this segment and those which follow as in *L. niveus.*

Last segment with a small, slender pencil of parallel hairs which are not as long as the hairs of the lateral prominences on the preceding segment. There seems to be no secondary cluster of hairs below the pencil as in *L. niveus.*

Legs with the spine at the ventral third of the last joint larger than the terminal claw.

[1] In locality citations the names of O. F. Cook and the writer have been abbreviated to the initials of the last names.

Subclass CHILOGNATHA

Six of the nine recognized orders of this subclass have been found in Hispaniola. Characters for the separation of the orders are given in the following key.

Key to the orders of Chilognatha in Hispaniola

Segments open underneath, the arched dorsal plates not attached at the sides, the pleurae and pedigerous laminae free; legs of segment 7 normal, those at the posterior end of the body modified in the male for copulatory purposes . . *Limacomorpha*

Segments closed underneath, the dorsal plates joined at the sides to the pleurae or completely fused; legs of segment 7 of the males modified for copulatory purposes; posterior legs normal . . . . . .

Number of segments 18, 19, or 20; each a complete ring, the pleurae and pedigerous laminae completely fused and with the sutures obliterated; only the anterior pair of legs of segment 7 modified as gonopods . . . . . *Merocheta*

Number of segments more than 20; pedigerous laminae distinct, free or united by evident sutures; posterior pair of legs of segment 7 specialized as gonopods, and usually both pairs so modified . . . . . .

Head very small, with a pointed snout or beak, the mouthparts poorly developed; body convex above, flattened beneath, with large pleurae joined to the dorsal plates at the lateral angle; eight pairs of legs in front of the gonopods . . . . . *Colobognatha*

Head and mouthparts well developed; body not flattened below, nearly cylindrical; seven pairs of legs in front of the gonopods . . . . . .

Segments 4 and 5 with one pair of legs each; clypeus with a median suture . . . . . *Anocheta*

Segment 4 without legs, segment 5 with two pairs; clypeus without a median suture . . . . . .

Body laterally compressed; segments rather thin and fragile, with a distinct median suture and sculptured with fine, oblique striations; pedigerous laminae free . . . . . *Monocheta*

Body cylindrical; the segments hard and firm, with no median groove or suture; striations longitudinal on the posterior subsegments; pedigerous laminae united on the sides by a suture . . . . . *Diplocheta*

Order LIMACOMORPHA

Family GLOMERIDESMIDAE

Glomeridesmus Gervais & Gould

After examination of the two Hispaniolan species which have been referred to this genus the possibility is suggested that the characters given by Pocock[1] for the separation of the East Indian *Zephroniodesmus* from the tropical American *Glomeridesmus* may have been poorly chosen. Neither of the Hispaniolan species has the antennal sockets open behind, although a deep depression, extending downward from the posterior border of each socket to the margin of the head, might give that impression. While specimens of *Zephroniodesmus* were not examined, it was observed that the antennae of *C. concolor* are quite close together at the base, while those of *G. jenkinsi* are considerably more separated, from which it appears that this character is of more specific than generic value.

A condition not heretofore reported for this family is found in *G. jenkinsi*, the females of which all have 21 segments, instead of 20 as in the male, thus increasing the maximum number of segments for the family by one. In Pocock's description of the family (loc. cit.) he states that the body consists "of 19–20 segments" but does not say that the different number of segments is dependent on the sex of the animal, but there is the unique possibility of this being so, although the single definitely known case, just mentioned for *G. jenkinsi*, may not be considered sufficient grounds for such a generalization.

Glomeridesmus concolor Chamberlin

Glomeridesmus concolor Chamberlin, Bull. Mus. Comp. Zoöl., **62**, No. 5, p. 172, 1918. Two female specimens collected at Fond des Negre, June 28, 1927. C. & L.

They are colorless in alcohol. The length of these specimens, which appear to be fully mature, is 3.5. mm. but there do not appear to be other sufficient differences between them and *G. concolor*, which came from Jacmel, to justify another name. The smallest specimen of *G. concolor* Chamberlin reported was 4 mm. long.

[1] Contributions to our knowledge of the Arthropod Fauna of the West Indies. Jour. Linn. Soc., **24**, No. 157, p. 475–477, 1894.

Glomeridesmus jenkinsi new species

One male type and 6 females collected at Le Borgne, March 26, 1930, by W. H. Jenkins and C. A female collected on Morne Pilboreau, March 28, 1926, C. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. This is the only species with the pit behind each antenna triangular in outline, it being nearly circular in the other known species.

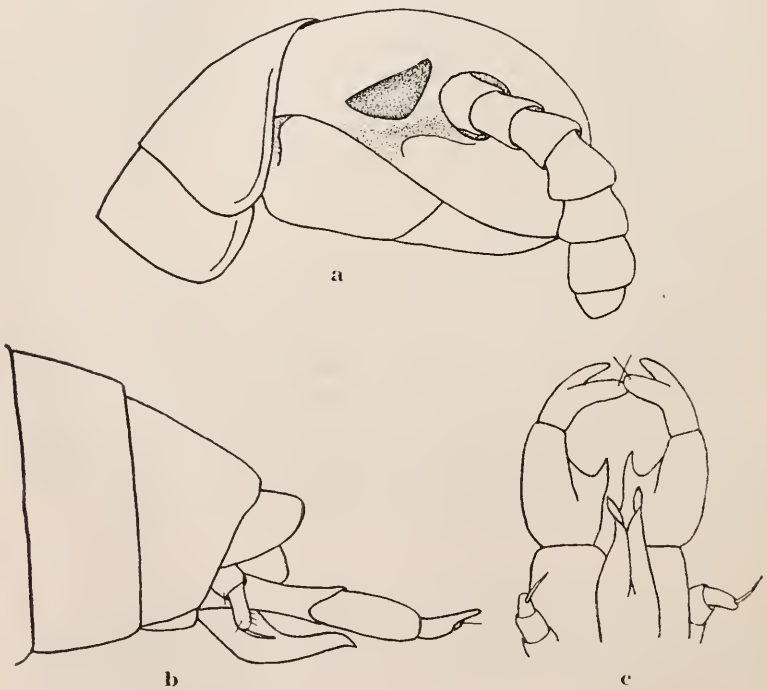


Fig. 2. *Glomeridesmus jenkinsi. a*, Oblique lateral view of head and segments 1 & 2; *b*, Lateral view of segments 18, 19, & 20, showing the last legs and gonopods; *c*, Ventral view of the gonopods and terminal joints of the last legs.

Description. Length of the male type 4 mm., width .8 mm., largest female 5 mm. long. The male has 20 segments but all the females have 21 segments.

Color in alcohol rather dark but this at least partly caused by the colored internal structure. Head light gunmetal, maculate with uncolored areas.

Head with the pit behind each antenna very definitely triangular, its upper side longest and the two lower sides subequal (Fig. 2, a). Antennae quite widely separated, much more than in specimens of *G. concolor;* the sockets not open behind, as given for *G. marmoreus* Pocock, but each socket is followed by a deep channel which passes below the pit to the lower margin of the head; the same condition was observed in specimens identified as *G. concolor.*

Surface of the segments strongly shining, the dorsal striae 3 or 4 in number and fainter than those in *G. concolor.*

Caudal segments with the posterior angles not in the least produced; those of the antepenultimate segment forming nearly right angles, and those of the penultimate segment much more obtuse. Last segment not extending downward on the sides to the level of the other segments.

Pleurae with the posterior margins continuous but with a few fine setae projecting backward from the margins.

Penes not protruded. Definitely formed, jointed gonopods project backward, behind the modified last legs of the male, as shown in (Fig. 2, b & c).

Order COLOBOGNATHA

This order is represented in Hispaniola by two families, the *Siphonophoridae* and the *Polyzoniidae;* the former containing eyeless millipeds with a large number of segments and with the head produced into a slender, sharp pointed beak; the latter family is represented by a single species having few segments, 37 to 44, the head with a single large ocellus on each side, and the front of the head acutely angled but not produced into a long attenuated beak.

Family SIPHONOPHORIDAE

Two genera of this family have been found in Hispaniola; *Siphonophora* and *Siphonocybe.* In *Siphonophora* the repugnatorial pores are not borne on distinct prominences on the sides of the body as in *Siphonocybe,* which has a strong lateral projection or keel, supporting the pore, on the side of each segment. At the caudal end of the body these keels project behind the back margin of each segment.

Genus Siphonophora Brandt

The three species are separated in the following key.

Key to the Hispaniolan Species of Siphonophora

Body slender, clothed with short, fine hairs, except on the last segment where the hairs are much longer . . . . *S. gracilior* Chamberlin

Body stouter, dorsum with hairs of uniform length throughout . . . . . .

Body broad and depressed; color brownish; dorsal hairs short; beak longer than the head but reaching only to the sixth joint of the long antennae . . . . . *S. manni* Chamberlin

Body narrower and more convex; color yellow; dorsal hairs moderately long; beak shorter than the head, decurved, antennae short and thick . . . . . *S. proxima* Chamberlin

Siphonophora gracilior Chamberlin

Siphonophora gracilior Chamberlin, Bull. Mus. Comp. Zoöl., **62**., no. 5, p. 173, 1918.

A small specimen of what appears to be this species was collected at Petionville, the type locality, June 17, 1927. L.

Siphonophora proxima Chamberlin

Siphonophora proxima Chamberlin, Bull. Mus. Comp. Zoöl., **62**, no. 5, p. 173, 1918.

Small specimens, apparently of this species, but with a greatly reduced number of segments, were collected at the following places: Petionville, June 17, 1927. L.; Trouin, June 22, 1927; Diquini, June 26, 1927; between Leograne and Petit Goave, June 28, 1927. C. & L.

Siphonophora manni Chamberlin

Siphonophora manni Chamberlin, Bull. Mus. Comp. Zoöl., **62**, no. 5, p. 173, 1918.

Type locality. "Grande Riviere."

The locality probably refers to the river by that name which flows through Jacmel.

Siphonocybe Pocock

A new member of this genus has been found in Haiti and is described below. The only other species is native in Trinidad.

Siphonocybe alba new species

Six specimens (2 males) collected near Trouin, June 22, 1927, C. & L., May 21, 1930, C., and one female from between Leogane and Petit Goave, June 28, 1927, C. & L. Several specimens from the type locality June 26, 1934, L. Type in U. S. N. M. Paratype in M. C. Z.

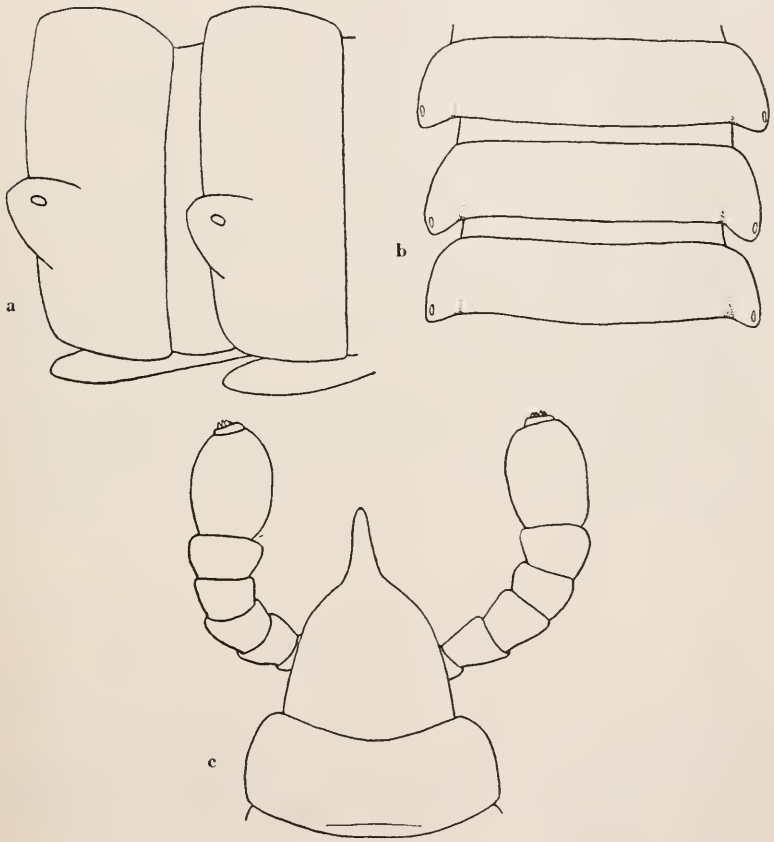


Fig. 3. *Siphonocybe alba*. *a*, Lateral view of two posterior segments; *b*, Dorsal view of three posterior segments; *c*, Dorsal view of head and first segment.

Diagnosis. This species differs from *S. harti* Pocock in being more slender, of smaller size, and with very short pubescence on the dorsum,

which could not be described as "silky." This species is white, whereas *S. harti* is buff in life, turning darker in alcohol.

Description. Body long and slender; living color transparent white without any tinge of reddish.

The largest specimen, a female, is 14 mm. long and has 61 segments.

Dorsum strongly convex and appearing almost naked, but with the last segment with a few fine hairs 10 or 12 times as long as those on the mid-body segments. Segments with a lateral poriferous carina on each side, this more conspicuous on the caudal segments where it actually projects beyond the back margin of the segments; pores borne laterally near the posterior corner of the carinae (Fig. 3, a & b).

Head long; with the antennae long, clavate, moderately compact; beak slightly decurved, shorter than the head, scarcely reaching the sixth joint of the antennae, (Fig. 3, c).

First segment half again as wide as the head at base, and about as long as the next two segments combined.

Anal valves with many long hairs crossing above the opening. Preanal scale short, broadly rounded behind, and with 6 or 8 long hairs apparently in a single transverse row.

In the male type the first 4 segments each appear to have a single pair of legs, and the next 2 segments each with 2 pairs of legs; the 2 pairs of modified gonopod legs arising from the seventh segment. Behind the gonopods there are 91 pairs of legs, the last pedigerous segment seems to have but a single pair, and this condition appears to exist in the females also.

Family POLYZONIIDAE

Siphonotus Brandt

Siphonotus purpureus Pocock

Siphonotus purpureus Pocock, Jour. Linn. Soc. Lond., **24**, p. 479, 1894.
S. virescens Silvestri, Anal. Mus. Nac. Bs. As., **6**, p. 55, 1898.
This species collected by W. R. Mann at Cape Haitien, Ennery, and Grande Riviere. Collected at Petite Riviere de Artibonite, Plaisance and Bayeux, C. & L.

The species also has been reported from the islands of St. Vincent and Tobago. O. F. Cook and the writer have collected specimens at Belize, British Honduras, and in the Panama Canal Zone, and the writer found the species plentiful in Dominica, Guadeloupe, Martinique, Trinidad and Surinam.

Careful examination of these specimens has failed to show a single one with 2 ocelli on each side of the head, as described by Pocock, and it is apparent that his description was in error. Specimens described by Silvestri as *S. virescens* quite evidently belong to this species.

Order MONOCHETA

Family STEMMIULIDAE

Prostemmiulus Silvestri

In this genus the species appear to be decidedly localized, as few have been found distributed over more than a relatively small area. The external differences of the species are few and seldom distinctive, and a single color pattern predominates, with about as much variation within each of the species as between them. Only one rather extreme modification of pattern has been found in the Hispaniolan forms and intermediates between it and the common series possibly exist. Identification of the species by external characters is difficult and final judgment should rest on the examination of the male organs, but the following key may assist in the recognition of the species.

Key to the Hispaniolan species of Prostemmiulus

Mid-dorsal stripe not continuous on the segments but reduced to a light spot on the anterior portion of each segment..... *interruptus* new

Mid-dorsal stripe usually continuous, at least on the mid-body segments.....

Mid-dorsal stripe broad..... *venustus* new

Mid-dorsal stripe narrow.....

First segment with 2 strong striae low down on each side..... *clarus* Chamberlin

First segment with 3 or 4 striae on each side.....

Males with the raised pleural lobe of segment 4 produced forward and inward and hidden behind the middle of the raised inner margin of the pleura of segment 3; gonopods with the inner divisions terminating in two slender arms..... *abditus* new

Males with the raised pleural lobe of segment 4 not produced forward or hidden by the pleura of segment 3; gonopods with the inner divisions broadly truncated at apex or surmounted by a single slender arm .....

First segment with three striae on each side; usual number of segments apparently 42 ..... *subulatus* new

First segment with four striae on each side; number of segments not exceeding 41 .....

Males with the third legs very conspicuously swollen, the last joint clawless ..... *claripes* new

Males with the third legs of normal size and with a terminal claw .....

Males with the inner margin of the pleura of segment 3 definitely raised ..... *quadristriatus* new

Males with the inner margin of the pleura of segment 3 but slightly or not at all raised .....

Body reaching a length of 18 mm. number of segments usually 41; gonopods with the inner divisions subtruncate at apex, not ending in a long slender arm ..... *cognatus* new

Body not exceeding 13 mm. in length; segments never more than 40 and usually less; gonopods with the inner divisions ending in a slender arm .....

Pleurae of the third segment of the male with the inner margin slightly elevated, females with the posterior margin of each pleura of this segment emarginate, and the inner posterior corner a right angle; inner division of each gonopod with the basal two-thirds very thick, deeply hollowed at apex, apical third consisting of a slender arm rising from the front face of the basal portion and extending upward and inward ..... *affinis* new

Pleurae of the third segment of the male with the inner margin almost flat; females with the posterior margin of the corresponding pleurae not emarginate, the inner posterior corners very broadly rounded; inner division of each gonopod with the basal two-thirds not especially thickened and not hollowed at the top, the apical arm more erect and continuous with the basal portion ..... *heterops* new

Prostemmiulus venustus new species

Five mature females (1 the type) collected on Morne Brigand, near Bayeux, July 16, 1927, L. Two female specimens collected on Morne Pilboreau,

above Ennery, and two other females collected at Plaisance, July 8, 1927. C. & L., appear to belong to this species. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. The broad, light colored, median band of the body immediately distinguishes this handsome species from the other forms.

Description. Length of the largest female 18 mm. Number of segments 39 to 41.

Body moderately slender, not as strongly attenuated behind as usual, the anterior three-fourths of the body with the sides nearly parallel, scarcely at all converging behind.

Median longitudinal light stripe of the dorsum wider than in any other Hispaniolan species, light salmon-colored in the specimens in alcohol but probably pinkish in life; each side of the body with two longitudinal rows of light spots arranged as in *P. clarus;* head and first segment of four of the specimens from the type locality light in color, similar to the median band, but in the remaining specimen the head and first segment are dark; last segment with the dorsal portion light, the sides somewhat darkened; anal valves with each disc light but darkening toward the raised margin.

Groove on the vertex of the head faint but long, reaching opposite the top of the antennal sockets; ocelli strongly differentiated in size; antennae as in *P. quadristriatus.*

First segment with 3 moderately impressed lateral striations on each side.

Third segment with the posterior margin, adjacent to the legs, with a quite deep, triangular emargination, the posterior corner immediately mesad of it rather broadly, triangularly produced.

Striations beginning to extend onto the dorsum on segment 5, the dorsal striations rather weak and inconspicuous. Notch at the posterior end of the dorsal median sulcus of the segments rather deep and more conspicuous than in *P. quadristriatus* or *P. subulatus,* especially on the posterior segments.

Last segment over half as long as the penultimate segment.

Anal valves scarcely at all convex, the raised margins thin. Preanal scale broadly rounded behind.

First 3 pairs of legs with a comb of fine, short hairs on the under side of the last joint of each leg.

Prostemmiulus clarus Chamberlin

Prostemmiulus clarus Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 176, 1918.

This species was reported from Jacmel, the type locality; Diquini; Grande Riviere; Furcy; and Manneville. Several females and young males collected at Diquini, August 21, 1927, C., appear to be this species.

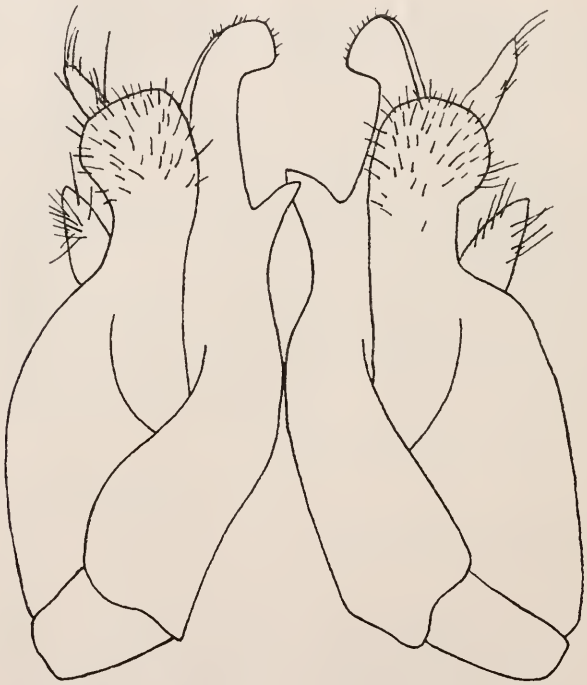


Fig. 4. *Prostemmiulus clarus.* Gonopods of paratype, anterior view.

The gonopods of Chamberlin's paratype, M. C. Z. No. 4315, are shown in figure 4.

Prostemmiulus abditus new species

One male (type), collected on Morne Pilboreau, above Ennery, July 8, 1927. C. & L. One male and 2 females from the same locality, May 12, 1925, C. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. The small size of the animal, with the body tapering backward from the first three segments; the hidden mesial lobe of the pleura on each side of the fourth segment; the lack of acute serrations along the posterior lateral margin of the segments; and the peculiar gonopods, are easily recognized characters of this species.

Description. Length 10 to 12 mm., number of segments 36 to 39. Body small, very slender, quite strongly compressed laterally in the

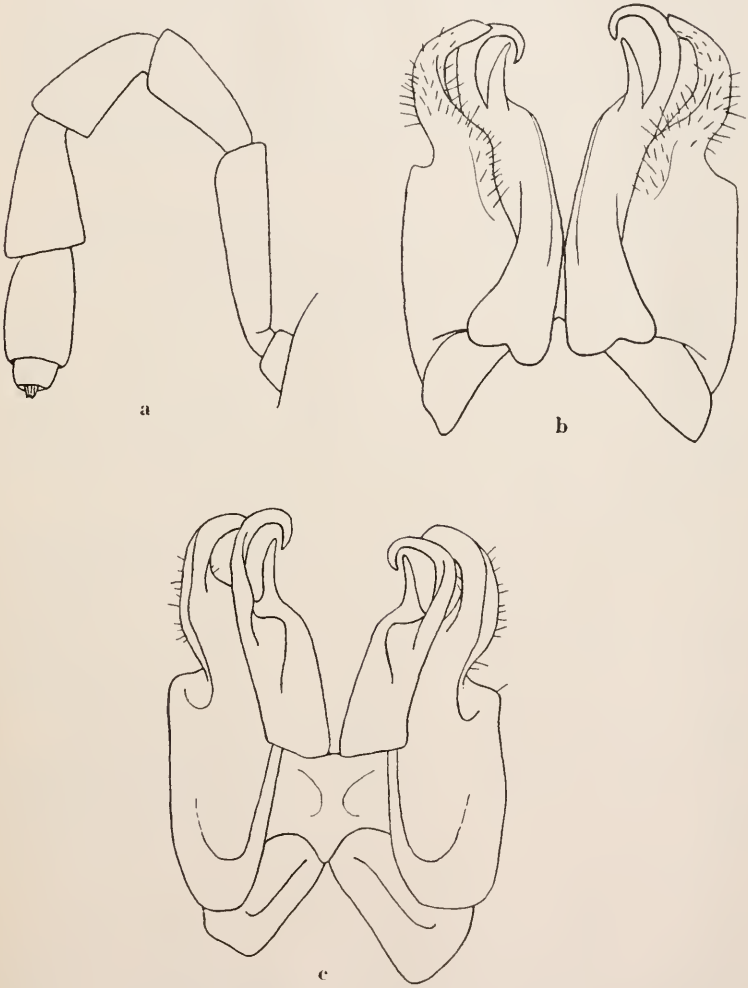


Fig. 5. *Prostemmiulus abditus*. *a*, Antenna; *b*, Gonopods, anterior view; *c*, Gonopods, posterior view.

male, narrowing very gradually to the posterior end from the first 3 segments which are broadest; female broadest near middle of the body.

Median light stripe narrow and continuous on the posterior segments but broader and confined to the posterior half of the segments at the front end of the body; on the side of each segment, and removed from the median line, is a very large light colored transverse area, reniform in shape with the concavity behind, the upper half of the area not solidly light colored as is the lower half; the pore is located in this area at its upper, anterior limit; on the posterior segments this colorless area is greatly reduced in size and is broken up into a few tiny spots; head, last segment, and anal valves dark colored.

Head with the lower eye small, the upper eye of moderate size; groove of the vertex short; antennae with joint 2 longest, joints 3, 4 and 5 subequal, and joint 6 almost as long as the fifth joint (Fig. 5a).

First segment with 3 definite striations on each side.

Third segment with the inner margin of the pleura on each side definitely but not suddenly raised.

Inner margin of the pleura of each side of the fourth segment strongly produced forward and inward into a long subacute lobe with its apex mesad of the middle of the raised margin of the pleura of the third segment and not as greatly elevated as it is, thus being hidden from lateral view by the pleura of the third segment.

Striations beginning to extend onto the dorsum on segment 5; the dorsal striations very distinct, never more than 4 on each side above the pore. Posterior margin of the segments on the ventral half of the body not sharply serrate, the corners below each of the striations scarcely projecting, forming a right angle except in the immediate vicinity of the feet where the corners are sharper and more produced. Notch at the end of the dorsal median sulcus of each segment not especially different from that in *P. quadristriatus* or *P. subulatus*.

Last segment with the setiferous processes shorter than usual.

Anal valves moderately convex, the margins thin and not greatly raised. Preanal scale broadly truncate-rounded behind, nearly straight across.

Gonopods as shown in figure 5, *a* and *b*.

Prostemmiulus subulatus new species

A number of males and females collected on Morne Brigand, near Bayeux, July 16, 1927, L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Closely related to *P. quadristriatus* but slightly larger; usually with one more segment; the median light stripe of the segments broader; the ventral longitudinal margin of segments 3 and 4 less

elevated; and the gonopods with several definite differences, as reference to the drawings will show.

Description. Length of the largest male 21 mm., and with 42 segments; largest female 22 mm. long, with 42 segments, the usual number apparently.

Body shaped much as in *P. quadristriatus* but more evenly and continuously tapering caudad from the broad fifth, sixth and seventh segments; the females indistinctly narrowed caudad from in front.

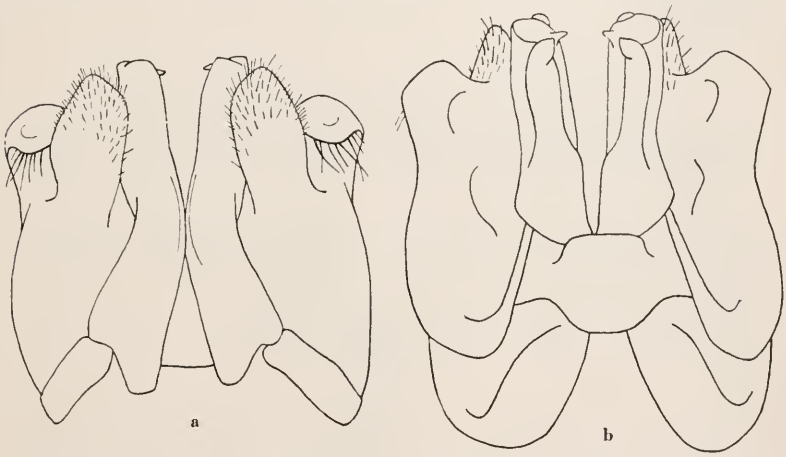


Fig. 6. *Prostemmiulus subulatus. a*, Gonopods, anterior view; *b*, Gonopods, posterior view.

In the color pattern the median light band sometimes moderately wide, sometimes as narrow as in *P. quadristriatus*, otherwise the coloration is as in *P. clarus*.

Head with the sulcus of the vertex obsolete; upper ocellus large, the lower one distinctly smaller.

First segment with 3 moderately impressed striae on each side.

Third segment of the males with the ventral longitudinal margin on each side only slightly raised; the corresponding margin of the fourth segment prominently raised as in *P. quadristriatus* but not as high. Third segment of the females with the emargination of the ventral posterior margin, adjacent to the legs, deep but much shorter than in *P. quadristriatus*, the posterior corner produced into a long, acute angle.

The striations begin to extend onto the dorsum on segment 5. Notch at the posterior end of the dorsal median sulcus on each of the segments deep, but narrow and inconspicuous.

Last segment not over half as long as the penultimate segment.

Anal valves slightly convex, the margins rather thin. Preanal scale broadly rounded behind.

Gonopods as shown in figure 6, *a* and *b*.

First and second male legs and the first three pairs of female legs, viewed *in situ*, do not appear to differ materially from those of *P. quadristriatus*.

Prostemmiulus quadristriatus new species

A number of males and females collected on Morne Pilboreau, above Ennery, May 4, 1925, C., May 13, 1927, L., and July 8, 1927, C. & L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. The gonopods show this species to be most closely related to *P. subulatus*. It is slightly smaller, usually has one less segment, and there are four striae on each side of the first segment, instead of three as in *P. subulatus*.

Description. Length of the largest specimen, a male, 18 mm., number of segments 41. Other large specimens usually with 41 segments.

Body not at all fusiform; the males distinctly subulate, broadest from segments 5 to 7 inclusive, behind which the sides taper backward, with the segments of the posterior third more strongly tapering; females with the anterior half of the body of nearly uniform width, the posterior half more strongly tapering than in the males.

Color much as in *P. clarus* but the median light line is very fine and somewhat interrupted on each segment; head, last segment and the anal valves dark.

Vertex of the head with a median groove evident just in front of the first segment; both ocelli large, but the upper one slightly larger; antennae with joint 2 longest; joint 3 slightly longer than joint 4 or 5 which are equal and longer than joint 6.

First segment with 4 striae on each side, the upper one longest, the others decreasing in length but all strongly impressed.

Third segment of the males with the mesial margin of the pleura on each side raised, especially near the posterior corner; ventral surface with a number of tiny, very short setae, a few similar ones in the same location on the next segment. Third segment of the females

with ventral, mesial margin not raised but the posterior margin broadly and deeply emarginate near the legs, the ventral posterior corner acutely produced caudad.

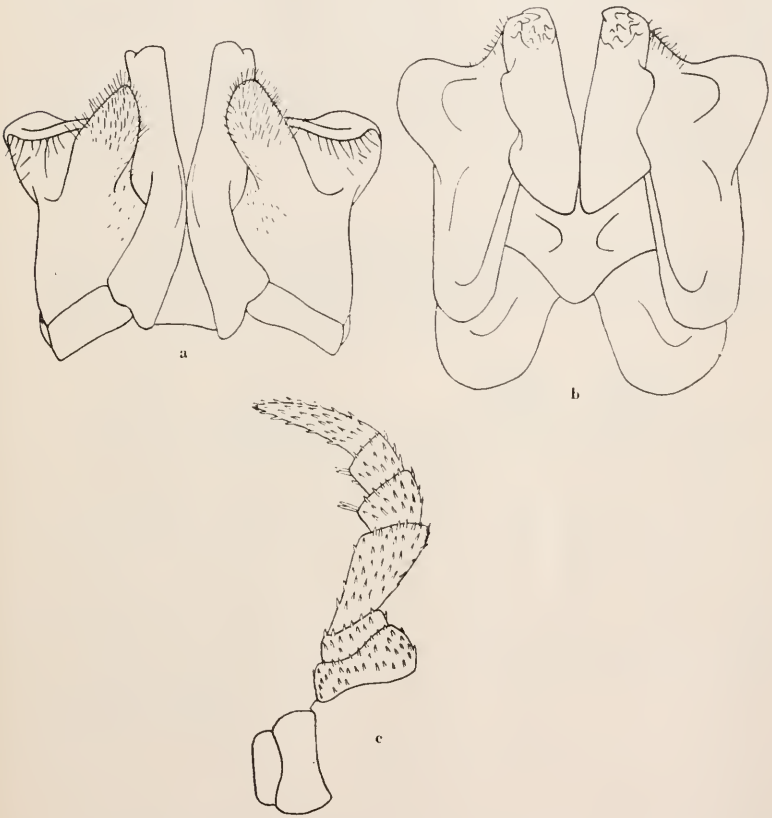


Fig. 7. *Prostemmiulus quadristriatus*. *a*, Gonopods, anterior view; *b*, Gonopods, posterior view; *c*, First male leg.

Fourth segment of the males with the mesial margin of the pleura on each side approaching much closer to the median line of the body beneath than on any of the other segments and produced into a slender, upright subacute lobe, with the apex reaching opposite the distal end of the coxal joint of the third leg.

Dorsal striations beginning on segment 5. Notch of the hind margin of the segments, at the end of the dorsal median sulcus, not especially deep or conspicuous, even on the posterior segments.

Last segment of the usual form, with 3 setiferous processes on each side.

Anal valves moderately convex and with the raised margins thin. Preanal scale with a slight angle behind at the middle.

Gonopods and the first legs of the male as shown in figure 7, *a*, *b* and *c*.

Females with a comb of fine hairs on the under side of the last joint of the first 3 pairs of legs.

Prostemmiulus interruptus new species

One male collected between 6000 and 7000 feet elevation at La Vestite, La Selle Range, Sept. 16–23, 1934 by P. J. Darlington. Type in M. C. Z.

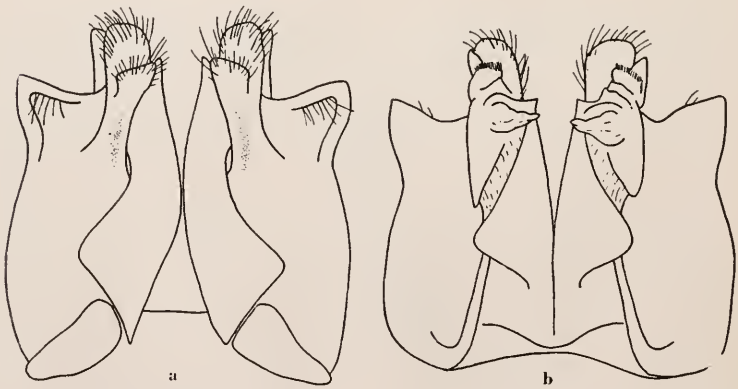


Fig. 8. *Prostemmiulus interruptus*. *a*, Gonopods, anterior view; *b*, Gonopods, posterior view.

Diagnosis. The definitely interrupted mid-dorsal light stripe is the most striking character of this species although possibly to be confused with *P. quadristriatus* which has the median stripe less obviously interrupted. The gonopods also indicate relationship with *P. quadristriatus*.

Description. Body about 15 mm. long, with 39 segments; somewhat fusiform, tapering backward from the posterior third.

In the alcoholic specimen the usual median light line is indicated

merely by a small spot on the anterior portion of each segment beneath the foregoing segment, through which it is slightly apparent. The head and several segments closest to each end of the body without light markings. On the other segments there is a large round light spot on the side and a still larger, elongate spot below this.

Ocelli strongly differentiated in size. Vertex of head strongly grooved.

First segment with four striae on each side but one of the striae on one side much shorter than on the other side.

Third segment of the male with the inner margin of the pleurae slightly raised.

Fourth segment of the male with the pleurae narrowed, produced inward and somewhat forward under the pleurae of segment 3.

Preanal scale rather large; evenly rounded behind.

Last segment with setiferous papillae short.

Gonopods as shown in figure 8, *a* and *b*.

Prostemmiulus cognatus new species

Plate 1, Fig. 1

Two males (one the type) and several females collected near Trouin, June 26, 1934 by E. M. and H. F. Loomis. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Relationship with *P. subulatus* and *P. quadristriatus* is indicated but the median light band of the dorsum is slightly wider; the sides of the body are more nearly parallel; and the inner margins of the pleurae of segments 3 and 4 are different; but the main difference is in the gonopods.

Description. Body rather slender, with sides parallel to the posterior third.

Length 16 mm. Number of segments 40 or 41.

Median light stripe of moderate width, parallel sided; a light spot, in the front of which the pore is located, on each side of the segment; beneath the poriferous spot is another slightly larger spot.

Head with the groove of the vertex long and faint. Upper ocellus not quite twice as large as the lower one; both strongly convex. Antennae with joint 2 longest; joints 3, 4 and 5 subequal; joint 6 from one-half to two-thirds as long as joint 5.

First segment with two long striae on the side, below which there are two short striae.

Third segment with the inner pleural margin simple, continuous, not elevated.

Fourth segment of the male with the inner portion of the pleura raised into a large triangular lobe.

Notch at the posterior end of the median sulcus exceedingly faint.

Anal valves but slightly convex, the raised margins thin. Preanal scale quite long, narrowly rounded behind.

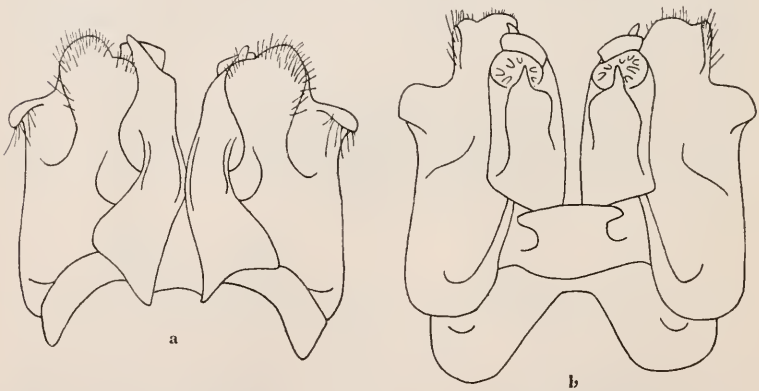


Fig. 9. *Prostemmiulus cognatus*. *a*, Gonopods, anterior view; *b*, Gonopods, posterior view.

Gonopods of the same general type as those of *P. quadristriatus* and *P. subulatus* but with obvious differences as shown in figure 9, *a* and *b*.

Second male legs reduced in size and number of joints and modified in shape, the apical joint bent forward near the middle.

Third male legs normal in size and structure.

Prostemmiulus clavipes new species

One male collected near Trouin, June 24, 1934 by E. M. and H. F. Loomis. Type in U. S. N. M.

Diagnosis. Very close to *P. cognatus* as shown by the similarity of the gonopods, but the much more tapering body and the greatly enlarged third legs of the male are notable differences.

Description. Number of segments 41. Length 18 mm. Width at the

second segment 1.6 mm. Body very strongly subulate, widest at the second segment behind which it narrows uniformly to the last segment. Color about as in *P. cognatus*, the anterior end of the body slightly lighter than farther back.

Head with the furrow of the vertex short.

First segment with one long marginal stria beneath which three much shorter ones decrease in length.

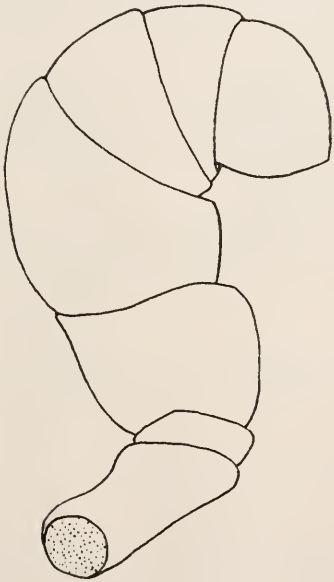


Fig. 10. *Prostemmiulus clavipes*. Third male leg, anterior view.

Segments 3 and 4 with the pleurae as in *P. cognatus*.

Second male legs smaller than in *P. cognatus* but of the same modified type.

Third male legs with normal number of joints but these, especially the five distal joints, very greatly swollen and the terminal joint is without a claw. (Fig. 10.) In *P. cognatus* the third male legs are of normal shape.

Gonopods indistinguishable from those of *P. cognatus*.

PROSTEMMIULUS AFFINIS new species

One mature male and two females, apparently lacking but one moult of maturity, collected between Petit Goave and Leogane, June 28, 1927. C. & L. Two males and one female from near Trouin, June 26, 1934, E. M. and H. F. Loomis. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. This species and *P. heterops* are very closely related as indicated by the general form of the gonopods which, however, differ in a number of particulars. The pleurae of the third segment of the males is slightly elevated near the legs in this species and the posterior

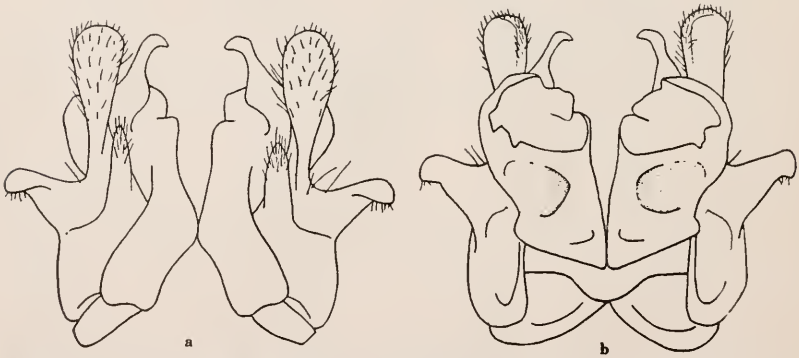


Fig. 11. *Prostemmiulus affinis.* *a*, Gonopods, anterior view; *b*, Gonopods, posterior view.

margin of the third segment of the females is definitely emarginate on each side near the legs and there is a right angled posterior corner.

Description. Length of the male type 11 mm., of the largest female 13 mm. The male has 40 segments and the females 32 and 36 segments.

Body of the male moderately compressed on the sides behind, narrowing from the anterior fourth caudad; both females especially stout for this genus and not in the least compressed on the sides, the posterior end of the body much less narrower than usual.

Color about as given for *P. clarus*, the median light stripe narrow but continuous and with the sides parallel.

All the specimens have 2 eyes on each side. Groove of the vertex short and slightly impressed. Antennae as in *P. abditus*.

First segment of the type with 4 conspicuous, rather widely sepa-

rated striae on each side; in the females they are less conspicuous and not so widely separated.

Third and fourth segments of the male with the pleurae on each side much as in *P. heterops*, the inner margin of the pleura on each side of the third segment slightly more elevated.

Posterior ventral margin on each side of the third segment of the females broadly but distinctly shallowly emarginate near the posterior corner, which is nearly a right angle, not produced caudad.

Striations beginning to extend onto the dorsum on the fifth segment as usual, the striations moderately distinct. Ventral half of the segments with the posterior margins as in *P. abditus* and *P. heterops*. Notch behind the median dorsal sulcus of the segments not especially conspicuous in the type but in both of the young females the notch in the caudal segments is broadly open behind and is quite conspicuous.

Last segment and anal valves as in *P. heterops*. Preanal scale broadly truncate behind.

Females with the usual comb of fine hairs on the under side of the last joint of the first 3 pairs of legs.

Gonopods as shown in figure 11, *a* and *b*.

Prostemmiulus heterops new species

One male and 3 females collected at Petionville, June, 17, 1927. L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. This species is distinguished by its small size; reduced number of segments; the nearly flat pleurae of the third male segment; and the continuous posterior-ventral margin on each side of the third female segment lacking a distinct corner near the leg; the presence of an additional ocellus on each side of the head in some specimens; and the structure of the gonopods.

Description. The largest specimen, a female, is 11 mm. long. Each female has 38 segments, the male type 36.

Body gradually narrowed caudad from the slightly broader fifth, sixth, and seventh segments; very strongly compressed laterally in the male, somewhat less so in the females, which are stouter.

Color much as in *P. clarus*, the median stripe quite broad; head and first segment in one female dark, the last segment light; in all the other specimens the head and first and last segments are light.

Head with the groove on the vertex of the male quite long and distinct but indistinct or obsolete in the females. The male has three ocelli on each side, the additional one below the usual two and much

smaller than the second one, round and dark colored but scarcely convex; the females all have the customary two ocelli on each side. Antennal joints of about the same proportions as in *P. abditus*.

First segment with 4 rather weak, closely placed striae on each side.

Third segment of the male with the inner margin of the pleura on each side flat, not distinctly elevated as in the majority of the Hispaniolan species. Pleura on each side of the fourth segment with the inner margin developed into a long, acutely pointed, erect lobe reaching over half way to the distal end of the coxa of the third leg.

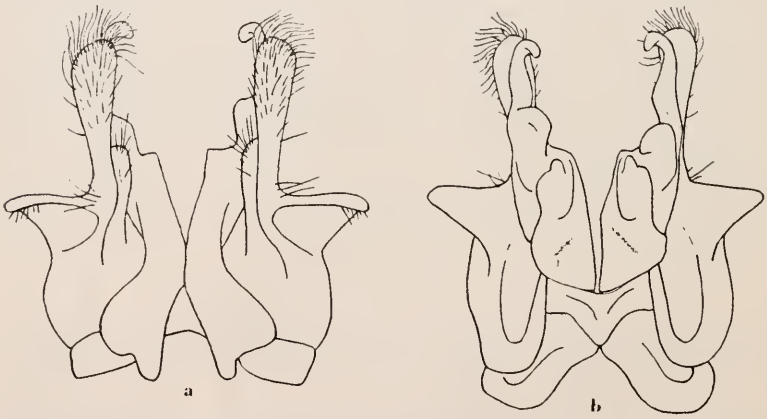


Fig. 12. *Prostemmiulus heterops*. *a*, Gonopods, anterior view; *b*, Gonopods, posterior view.

Third segment of the females with the ventral-posterior margin on each side continuous, not in the least emarginate near the feet, the posterior corner very broadly rounded and not at all produced backward.

Dorsal striations quite distinct, beginning on segment 5; posterior margins below the middle of the body as in *P. abditus*. Notch at the middle of the posterior margin of the segments not especially conspicuous.

Last segment of the usual form. Anal valves quite convex, the margins thinly elevated. Preanal scale rather narrowly truncate-rounded behind.

Females with the customary comb of fine hairs on the under side of the last joint of the first 3 pairs of legs.

Gonopods as shown in figure 12, *a* and *b*.

Order DIPLOCHETA

Two families belong to this order in Hispaniola, the *Epinannolenidae* and the *Spirostreptidae*, the former distinguished, in Hispaniola at least, by the much smaller size and the presence of pores on segment five. In the Hispaniolan species of *Spirostreptidae* the pores begin on segment six.

Family EPINANNOLENIDAE

Epinannolene Brolemann

Key to the Hispaniolan species of Epinannolene

Dorsum without a longitudinal light line at middle; first segment with a rather definite anterior corner on each side..... *haitiensis* Chamberlin

Dorsum with a longitudinal light line at middle; first segment without definite lateral angles.....

Segments conspicuously constricted, the surface behind the constriction strongly convex..... *convexus* new

Segments not noticeably constricted, the surface behind the sulcus not convex.....

Head and first segment light colored; median light stripe narrow; posterior margin of the segments dark colored; eyes composed of about 20 or 21 ocelli in 3 series; number of segments 49 ..... *ornata Chamberlin*

Head, first 3 segments, and last segment light colored; median light stripe very broad; posterior margin of the segments light; eyes composed of 25 to 33 ocelli in 4 or sometimes 5 series; number of segments 52 to 56..... *virgata* new

Epinannolene haitiensis Chamberlin

Epinannolene haitiensis Chamberlin, Bull. Mus. Comp. Zoöl., **62**, no. 5, p. 179, 1918.

The type locality is given as "Grande Riviere" which may be the Grande Riviere du Nord, near Cape Haitien, as the same species also was reported from Milot.

The present collection contains a female from Morne Pilboreau, and several other females from between Port Margo and Limbe, which appear to belong to this species. The largest specimen has 47 segments.

A mature female with 50 segments was collected at the Citadel. The specimens show a definite dorsal sulcus which is not located in a constriction.

Epinannolene ornata Chamberlin

Epinannolene ornata Chamberlin, Bull. Mus. Comp. Zoöl., **62**, no. 5, p. 180, 1918.

Localities. Petionville, Furcy and Port-au-Prince. Several females and one male collected at Kenscoff, June 24, 1934 by E. M. and H. F. Loomis. One male and two females collected at La Vestite, La Selle range, Sept. 16–23, 1934 by P. J. Darlington.

Largest female is 39 mm. long and 2.7 mm. wide. The specimens have a transverse sulcus, not in a constriction, on the dorsum of all segments except a few at each end of the body.

Males with the median ventral portion of segment 7 raised into a high ridge behind the gonopods; the anterior face of the ridge excavated for the gonopods with additional special recesses for their tips.

Gonopods rather closely resembling those of *E. virgata*, but with several more setae near the apex.

Epinannolene convexus new species

One male collected between 3,000 and 7,800 feet elevation on Morne La Hotte, Oct. 16–17, 1934, by P. J. Darlington. Type in M. C. Z.

Diagnosis. This species has the transverse constriction more pronounced than in the other three species. The color pattern and shape of the gonopods suggest close kinship with *E. ornata*.

Description. Body about 25 mm. long, with 58 segments. Anterior end of body constricted as in *E. virgata*, the first three segments gradually narrowing caudad to the fourth segment which is narrowest.

Color of the alcoholic specimen is generally brown; the head is brown between the eyes, the vertex mottled with many small light spots; first segment brown with a large transverse area of light spots on either side. Beginning with segment 2 there is a rather narrow mid-dorsal light line continuous after the first few segments; on the last segment it is wider than elsewhere. On the front half of some of the anterior segments the sides are maculate with light but on the remaining segments the color is more solid; posterior half of the segments light in color or transparent.

Ocelli in four series, 6, 7, 6, 4, forming an oval group.

First segment narrowly rounded on the sides, the lateral margin with a raised rim above which there are one or two striae extending forward from the posterior margin a little over half way to the front margin.

Segments with a pronounced constriction containing the transverse sulcus which is prominent across all segments from the fourth to near

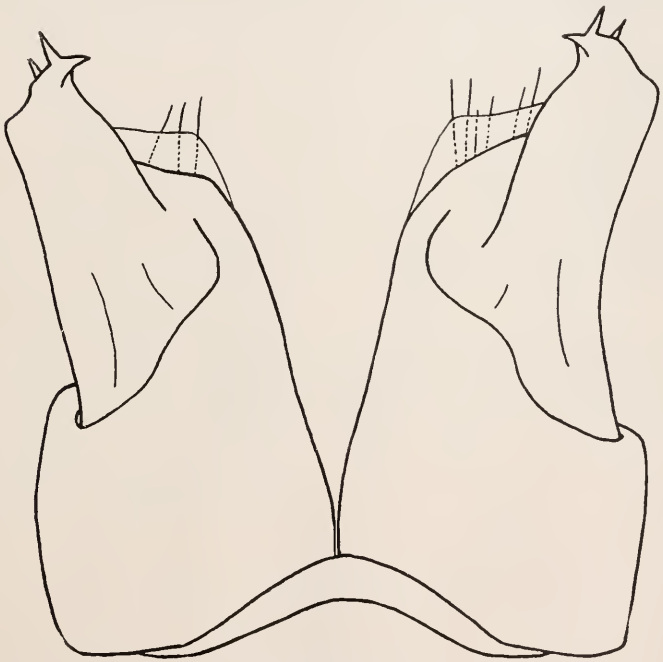


Fig. 13. *Epinannolene convexus.* Gonopods.

the caudal end of the body. Surface behind the constriction strongly convex. Surface of segments with tiny, short, longitudinal scratches and very minute reticulations, the scratches especially evident in the constriction immediately behind the transverse sulcus. Pores large, surrounded by a distinct rim.

Preanal scale transverse, the posterior margin only slightly rounded.

Gonopods broader than in the other species and with noticeable differences in form as seen in figure 13.

Seventh segment of the male with the ventral median portion raised into a crest behind the gonopods, the crest higher and more produced backward on each side of the middle than at the middle.

Epinannolene virgata new species

A number of female specimens were collected near Trouin, June 22, 1927, C. &. L. A young male and female from the same locality, April 11, 1926, C. Many others including males (1 the type) were collected here June 26, 1934 by E. M. & H. F. Loomis. Type in U. S. N. M. Paratype in M. C. Z.

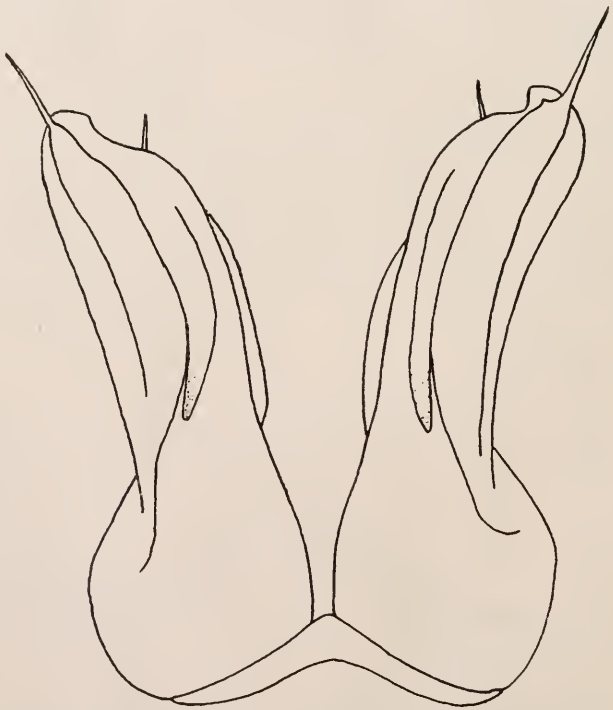


Fig. 14. *Epinannolene virgata.* Gonopods, anterior view.

Diagnosis. Not only does this species differ materially from the other two in having the head, first three segments and the last segment uncolored, but the number of segments and ocelli are greater.

Description. Length up to 32 mm., width to 2 mm. Number of segments 52 to 56.

In life the color of the head, first 3 segments, last segment, and anal valves is pinkish-yellow; the other segments with a very broad,

continuous, longitudinal band of cream color on the dorsum; posterior margin of each segment with a broad annulus of yellowish-white reaching to the pore, in front of which the segment is dark, almost black, except at the middle of the dorsum.

Eyes composed of from 25 to 35 ocelli usually in 4 series but there are 5 series in one specimen.

First segment narrowed on the sides, rounded, without any suggestion of angles; lateral rim reaching to the eye, surface within the rim usually lacking striae, but sometimes with a short one.

Anterior end of the body strongly narrowing backward from the first to the fourth segment, which is the narrowest, behind which the segments broaden gradually. Lateral striae prominent on only a few segments near the anterior end of the body where they are remote from the pores; succeeding segments with the striae confined to the ventral surfaces and not extending beyond the limit reached by the third joint of the legs. Transverse sulcus faint on all but the anterior segments and not at the bottom of a constriction, surface behind it not noticeably convex.

Preanal scale transverse, the posterior margin nearly straight across from angle to angle. Tab-processes on each side, similar to those of the *Cambalidae,* are well developed and when this genus is better known it may be found necessary to reduce the *Epinannolenidae* to a synonym of *Cambalidae.*

Sterna very finely reticulated.

Gonopods shown in figure 14.

Family SPIROSTREPTIDAE

Orthoporus Silvestri

Three species belonging to this genus have been recognized in the island and are separated in the following key.

Key to the Hispaniolan species of Orthoporus

Preanal scale large, long; the posterior margin strongly produced backward to an acute angle ..... *triquetrus* new

Preanal scale short and of moderate size, the posterior margin nearly transverse .....

Surface of segments densely sculptured with fine longitudinal wrinkles or striae ..... *caelatus* new

Surface of segments quite brilliantly shining; under magnification very faintly coriaceous ..... *haitiensis* Chamberlin

Orthoporus haitiensis Chamberlin

Orthoporus haitiensis Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 183, 1918.
Specimens collected near L'Archaie July 6, 1927, and at Le Brande, near Gros Morne, July 7, 1927, C. & L. The type locality, St. Marc, is between these two places. One male from between Port-au-Prince and Petionville, June 22, 1934, L.

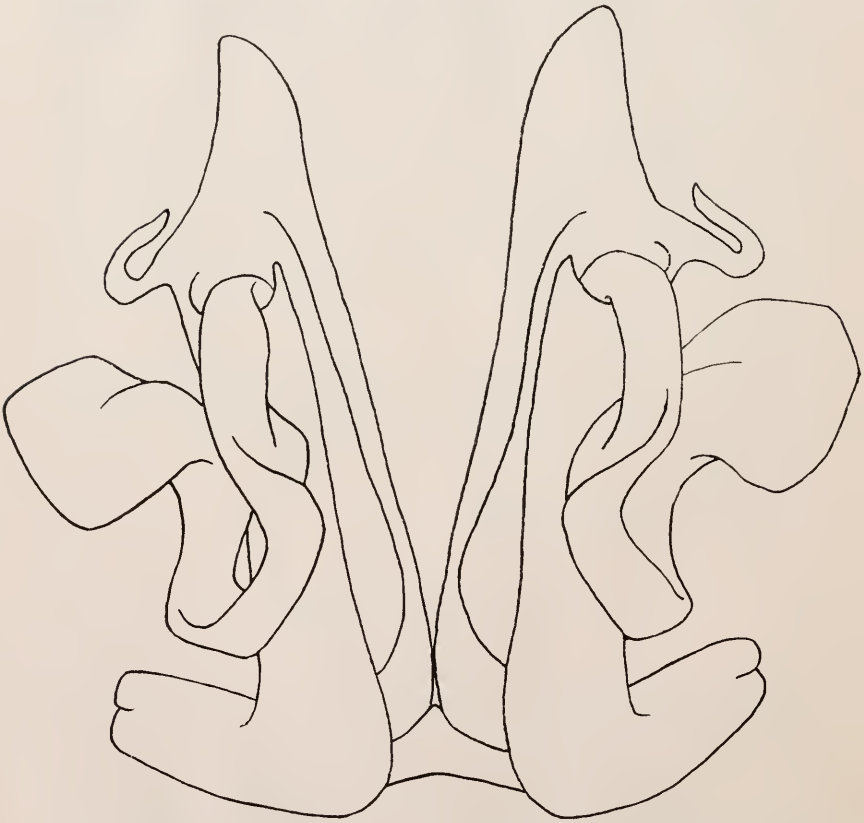


Fig. 15. *Orthoporus haitiensis*. Gonopods, anterior view.

None of the specimens has more than 55 segments.

Eyes separated by fully twice the diameter of one eye. The cluster is subtriangular, and counting downward from the top of the head the ocelli are in rows somewhat as follows: 1, 3, 4, 5, 5, 6, 7, 6, 6, 6, 4.

Surface of segments strongly shining, nearly smooth, but with moderate magnification it is seen to be very faintly and finely coriaceous, the sculpturing a little more pronounced near the posterior margin. While the long ventral striae do not approach close to the pores there are very short rudiments of striae in the strong transverse sulcus, and these rudiments frequently extend for a considerable distance above the line of pores. The sulcus is straight or slightly curved in front of the pore.

Preanal scale short, transverse, the posterior margin nearly straight across.

Gonopods of the male shown in figure 15.

Orthoporus triquetrus new species

A number of female specimens collected at San Lorenzo, Samana Bay, Dominican Republic, April 6, 1934, by Dr. Thomas Barbour, who also collected additional females on Saona Island, April 8, 1934. Type and Paratypes in M. C. Z.

Diagnosis. A slightly more slender and lighter colored species than *O. haitiensis*, and with more segments; different sculpturing; and a large, pointed, preanal scale.

Description. Length of largest specimen 50 mm., width 3.8 mm. Number of segments 59 or 60. Color apparently light fawn brown throughout in life, the specimens still retaining this color.

Head smooth and shining throughout, with a fine furrow on the vertex and 4 labral setae. Eyes separated by about twice the diameter of one eye; the cluster transverse, long, narrow, subelliptical, and with ocelli arranged downward from the top of the head somewhat as follows: 1, 2, 3, 4, 5, 5, 5, 5, 5, 4, 3, 1.

First segment as in *O. haitiensis*.

Ensuing segments with the exposed surface rather coarsely and densely coriaceous to the posterior margin; anterior covered portion of segment with 6 to 8 fine annular striae. Ventral striae as in *O. haitiensis* but the rudiments do not extend above the pores. Transverse sulcus strongly bowed forward in front of each pore.

Last segment with apex more angularly produced than in *O. haitiensis* but less depressed.

Preanal scale long, triangular; the posterior margin very strongly produced back to an acute median apex.

Orthoporus caelatus new species

A male type and two females collected between Port Margo and Limbe, June 13, 1927. L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. This species is very closely related to *O. sculpturatus* Karsch of Puerto Rico, as primarily indicated by the strikingly wrinkled surface of the segments, but the finger-like prolongation of the posterior piece of each gonopod, which may be seen without dissection, is the most readily observed distinctive difference. Also the first segment of *caelatus* has four sulci on each side as compared to two in *O. sculpturatus.*

Description. Color cinnamon brown; the male type 45 mm. long and 2.8 mm. broad and the largest female 60 mm. long and 4 mm. broad; number of segments 55 or 56.

Head with eyes separated by twice the transverse diameter of one eye, the cluster composed of about 36 ocelli in 5 vertical rows.

First segment with three deep sulci and a small, fine one close to the lateral margin; posterior corner on each side more nearly a right angle than the anterior one. (Fig. 16, *a*).

Surface of several of the anterior segments shining, finely punctate and slightly coriaceous but not distinctly wrinkled as are the other segments.

Ensuing segments with the dorsal surface longitudinally wrinkled, and the ventral surface coarsely striate, as described for *O. sculpturatus* by Silvestri, (Bull. Amer. Mus. Nat. Hist., **24**, p. 573, 1908), but the posterior third of the anterior subsegments is finely wrinkled, similar to the surface behind the transverse suture; while the anterior two-thirds has about five low but evident annular folds. Pores beginning on segment 6, small and separated from the suture by a third of the length of the subsegment. Rudiments of ventral striae continue up the transverse sulcus and entirely across the dorsum.

Last segment with a short, obtusely rounded apex; surface coarsely punctate-coriaceous.

Anal valves with rather thick, high, shining margins; surface elsewhere punctate, coarser near the raised margins than on the sides. Preanal scale short, four times as broad as long, the posterior margin only slightly produced backward at middle.

Gonopods with the anterior-internal curved pieces not toothed on the inner side as in *O. sculpturatus,* the expanded apex more rounded and with the margin nearly smooth; apex of each posterior piece pro-

duced into a slender, finger-like lobe far above the outer, lateral projection (Fig. 16, *b*).

Males with the fourth and fifth joints of all legs, except the first two pairs, with a distinct depression on the under side, occupying the

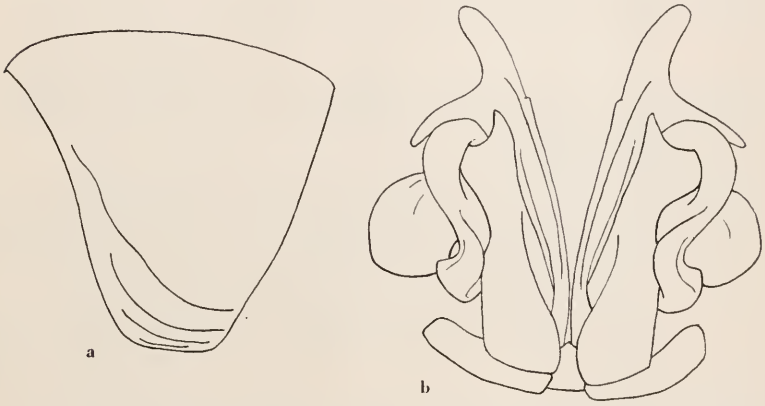


Fig. 16. *Orthoporus caelatus*. *a*, Segment 1 in lateral view; *b*, Gonopods, anterior view.

distal half of the joint. *O. sculpturatus* is said to have a pad on the under side of the same joints, and it is probable that the depressions of the Haitian species are formed by withdrawing of membranes capable of being inflated to form pad-like structures.

Order ANOCHETA

Family SPIROBOLIDAE

Key to the Hispaniolan Genera of Spirobolidae

Body 30 mm. or less in length; surface between the 3 divisions of the segments never impressed, but a transverse constriction, containing an impressed sulcus, usually crossing the middle of the midbelt; pore intermediate between this sulcus and the posterior margin of the segment; clypeal fovea 3 or 4 on each side ..... *Microspirobolus* Silvestri

Body longer than 30 mm.; sutures between the 3 divisions of the segments usually impressed, at least the one between the midbelt and hindbelt, the transverse constriction, when present, including this suture; pores in front of the suture; clypeal fovea 2 on each side.....

First segment with the sides acute; dorsal surface of the segments with coarse, crescentic impressions; color brick-red throughout ..... *Trigoniulus* Pocock

First segment with the sides rounded; dorsal sculpturing smoother, never consisting of crescentic impressions; color never brick-red throughout.....

Forebelt of the segments smooth, not in the least striate; males with the broad basal portion of the ventral plate of the gonopods with a very deep, semimembranous concavity on each side, the upper margin of the basal portion on each side of the apical prolongation partially covered by the lower part of the anterior plate; posterior plates broad, thin, subtriangular, the upper mesial corner of each bent back and out..... *Leiocricus* new

Forebelt of the segments somewhat striate, at least beneath; males with the ventral plate of the gonopods lacking a deep, semimembranous concavity in the basal portion on each side, and the margins of the plate entirely visible; posterior plates long, thickened and rather slender, the upper mesial corner of each not bent back and out.....

Species lacking scobinae..... *Cubobolus* Chamberlin

Species with scobinae.....

Gonopods with the anterior plates long and slender, the acute tips much exceeding the ventral plate; posterior plates long, thin and parallel-sided, much exceeding the anterior plates, the distal portion bent caudad and carried outside the body..... *Alcimobolus* new

Gonopods carried within the body and of the usual spirobolid type; the anterior plates short and transverse, seldom reaching the apex of the ventral plate; posterior plates rather short, tapering, thickened structures slightly or not at all exceeding the apex of the ventral plate.....

Species of very large size; with the inner gonopods each consisting of a single long, slender stylc..... *Cubocricus* Chamberlin

Species usually of smaller size; with the inner gonopods each bifurcate but sometimes with the two branches lying so close together as to resemble a single piece.....

Inner gonopods with both branches long and slender. . . . . *Nesobolus* Chamberlin

Inner gonopods with the outer branch broad, sometimes divided apically into two slender branches . . . . . *Rhinocricus* Karsch

Microspirobolus Silvestri

Key to the Hispaniolan Species of Microspirobolus

Segments not convex longitudinally nor marked above or on the sides with a transverse sulcus; coxae of legs 3 and 4 of the males produced into long lobes, the second joint of the fifth legs prominently developed beneath . . . . . *esulcatus* new

Anterior segments at least, with a distinct transverse sulcus crossing the dorsum, the surface behind it more or less convex; coxae and other joints of the pregenital legs of the males not strongly lobed . . . . .

Body with a few segments at each end coral pink, the intervening segments black on the dorsum and sides . . . . . *erythrotermus* new

Body not coral pink at either end, the intervening segments with a median dark band bounded on each side by a light band below which is a dark band . . . . .

First two segments yellow throughout . . . . . *lineatus* Chamberlin

First two segments at least partially dark . . . . .

Median dark band of the dorsum solid and continuous, not broken into figures . . . . . *furcianus* new

Median dark band sometimes solid on the anterior segments but partially split on each of the other segments, forming Y-shaped figures . . . . .

Segments bicolored, light gunmetal and white; anal valves and preanal scale light; each of the median Y-shaped figures with base in front, the branches pointing backward . . . . . *concinnus* new

Segments tricolored, pink, cream and nearly black; anal valves and preanal scale dark; each of the Y-shaped figures with the base behind, the branches pointing forward . . . . . *sigillatus* Loomis

Microspirobolus esulcatus, new species

Male type and other specimens collected on Morne Brigand, near Bayeux, July 16, 1927, L. Numerous females and one immature male of this species collected at Le Borgne, March 26, 1930, by W. H. Jenkins. Type in U.S.N.M. Paratype in M. C. Z.

Diagnosis. Resembling *M. lineatus* Chamberlin for which it was mistaken in collecting but in direct comparison with that species the body is stouter; the segments lack a transverse sulcus above or on the

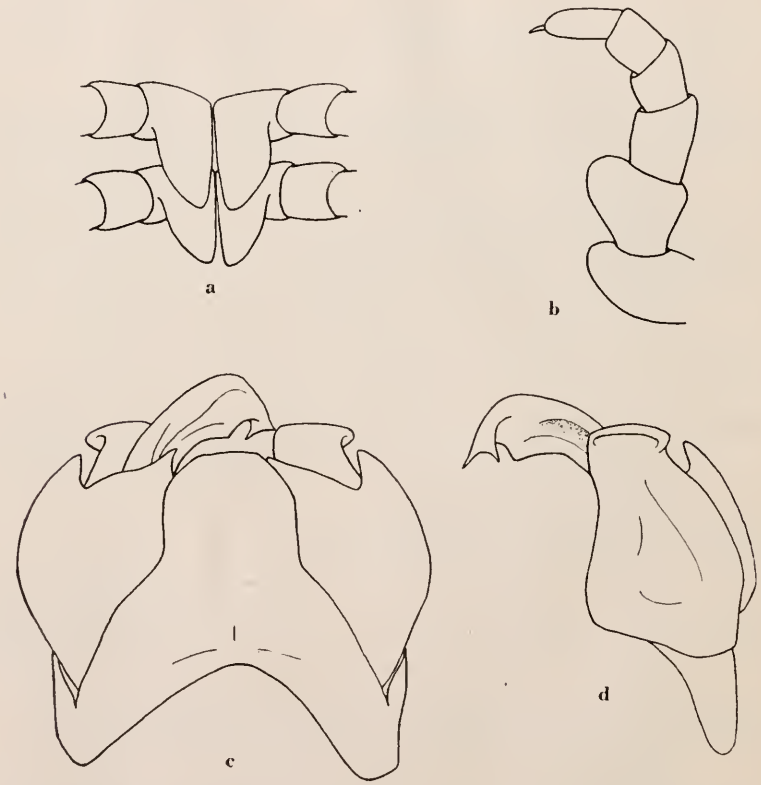


Fig. 17. *Microspirobolus esulcatus.* *a*, Basal joints of male legs 3 and 4; *b*, Fifth male leg; *c*, Gonopods, anterior aspect; *d*, One side of gonopods, posterior view.

sides; the coxae and other joints of some of the pregenital legs of the males show structural specializations and the gonopods are quite different.

Description. Color and number of segments as in *M. lineatus*, and the body of about the same length but stouter.

Head with eyes triangular, the individual ocelli scarcely separable, not convex when viewed by cross lighting. Clypeal fovea very inconspicuous, apparently varying from 2 to 4 on each side; surface of head smooth and shining, without a median furrow or transverse lines between the antennae.

First segment with the lateral angles more rounded and slightly narrower than in *M. lineatus*, and with the raised margin not continuing around the angles as in that species.

Other segments without any trace of a transverse sulcus above or on the sides, the posterior half of the segments flat instead of somewhat convex; transverse sutures between the 3 belts not the least impressed but sometimes visible as lighter lines in the integument; lateral sutures not impressed but sometimes showing in the integument. Surface of the segments smooth and very highly polished; ventral striae weak and not exceeding the tips of the legs.

Last segment a little more broadly rounded at the apex than *M. lineatus;* exceeded by the anal valves, which are evenly convex and not margined. Preanal scale a little more subtriangular than in *M. lineatus*, not evenly rounded from side to side.

Males with the coxae of legs 3 and 4 produced into very long lobes directed up and strongly caudad, those of the third legs inconspicuously larger (Fig. 17, *a*); coxae of the fifth legs very much produced but with the ventral side of the next joint developed into a large, rounded knob (Fig. 17, *b*): coxae and the second joints of legs 6 and 7 with processes decreasingly smaller than on the fifth legs.

Ventral crest of the seventh segment of the male elevated as in *M. lineatus*, the anterior edge emarginate in the same way.

Gonopods as shown in figure 17, *c* and *d*.

Microspirobolus erythrotermus, new species

Many specimens, including the male type, collected at Le Brande, July 7, 1927, C. & L. Type in U. S. N. M. Paratype in M. C. Z.

The animals were all found in the humus material accumulated in pockets on the top of huge, rough rocks in the woods, but none was found in the humus-covering of the ground itself.

Diagnosis. This beautiful and distinctive species has a black head, a few of the anterior and posterior segments light coral red, and the intervening segments bluish black.

Description. The largest specimen, a female, measures 28 mm. in

length and 3 mm. in breadth, the males are smaller and more slender than the females. Number of segments 41 to 45.

In life the body is strongly shining; the head black; segments 1 to 4 inclusive light coral-red above and below; segments 6 and 7 with the red color converging caudad on the dorsum to a blunt point on the posterior part of segment 7, the sides of the 2 segments and the remainder of the body to the penultimate segment bluish-black; posterior border of the penultimate segment and the entire anal segment, except

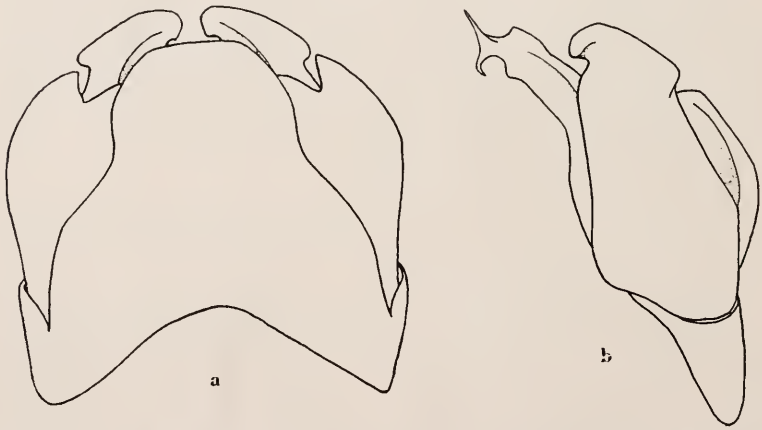


Fig. 18. *Microspirobolus erythrotermus*. *a*, Gonopods, anterior view; *b*, One side of gonopods, posterior view.

the lighter colored apex, similar in color to the first segments; ventral surfaces adjacent to the base of the legs, anal valves and preanal scale light pink.

Head with eyes triangular; the ocelli inconspicuous, not convex when viewed by cross lighting; median furrow impressed on the front and clypeus, the latter with 3 or 4 fovea on each side.

First segment with the sides moderately broadly rounded and with a strong raised rim proceeding from the lower corner of the head around the angle to the posterior margin, the rim narrower on the angles than in front.

Ensuing segments with the transverse sutures between the 3 belts showing as light lines in the integument, the suture between the mid- and hindbelt not distinctly impressed but in the bottom of a broad and shallow constriction which is less conspicuous on the dorsum than on

the sides. Lateral suture showing light colored in the body-wall but not impressed except infrequently on the hindbelt immediately after the pore. Pores located directly in the bottom of the transverse constriction, apparently opening through the suture. Surface of the segments smooth and shining, 8 to 10 ventral striae on the hindbelt and rather prominent, not reaching the tips of the legs; striae on the fore- and midbelt finer and more numerous.

Last segment abruptly rounded behind, almost acute, and very slightly exceeding the summit of the anal valves as seen from the side. Valves strongly convex, not margined, meeting in a deep groove. Preanal scale subtriangular, broadly rounded at apex, each side shallowly emarginate near the lateral angle.

Males with the coxae of legs 3, 4 and 5 a little produced, the outer joints not modified beneath; other legs normal.

Ventral crest of the seventh segment of the males low, less definitely raised than in *M. lineatus* or *M. esulcatus* but similarly broadly emarginate at the middle in front.

Gonopods as shown in figure 18, *a* and *b*.

Microspirobolus concinnus, new species

A great number of specimens were collected on Morne Brigand, near Bayeux, July 16, 1927. L. The type is a male in the U. S. N. M. Paratype in M. C. Z.

Diagnosis. The light, complicated markings; small circular eyes with prominent ocelli; simple pregenital legs of the males; and the form of the gonopods distinguish this handsome species.

Description. The largest specimen, a female, is 25 mm. long and 2.5 mm. broad; the males shorter and more slender than the females. Number of segments 39 to 42.

Living colors white and light grayish-gunmetal. Head dark except the clypeal region. First segment white except a small dark Y-shaped figure at the middle behind, with the ends of the branches nearly reaching the posterior margin. Along the middle of the dorsum of the ensuing segments is a broad dark band appearing continuous, but with slight magnification the posterior margin of each segment is seen to be narrowly white with the dark color on the forebelt of the next segment showing through; on each of the anterior segments the dark area is slightly emarginate behind but on the segments further back the excision is deeper and the dark color is in the form of a Y, with its base on the forebelt and its tips stopping considerably short

of the posterior margin of the hindbelt. Laterad of the median markings the color is white to near the pores where it changes to dark and

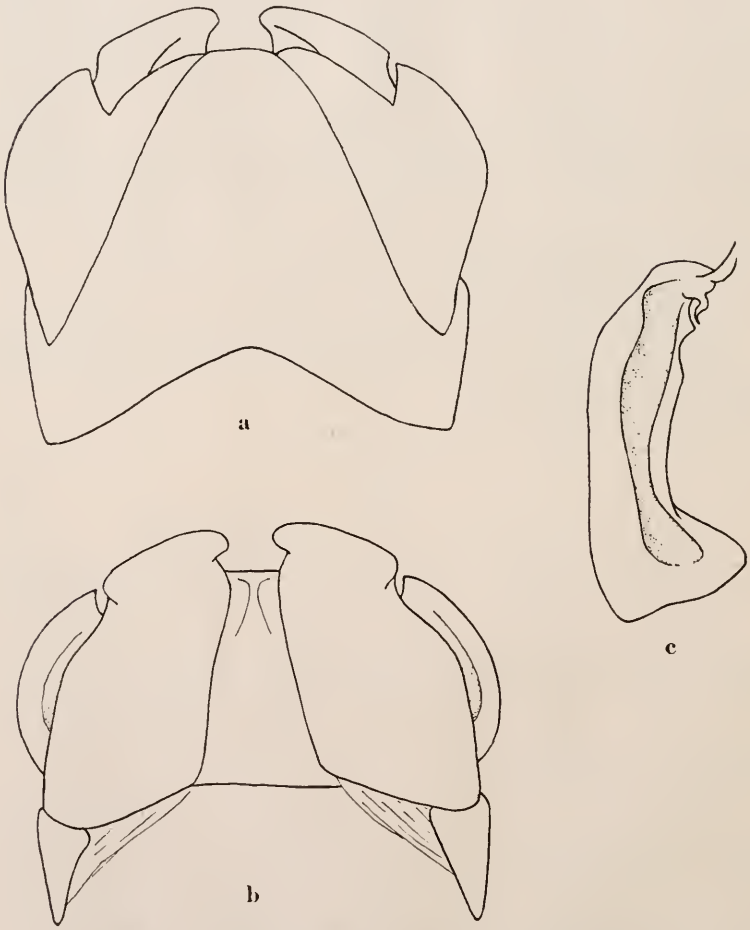


Fig. 19. *Microspirobolus concinnus*. *a*, Gonopods, anterior view; *b*, Gonopods, posterior view; *c*, Inner gonopod, posterior view.

a little distance below the pores this dark color begins to recede from the hindbelt and is gradually restricted to the mid- and forebelt and does not extend ventrad to the tips of the legs. Last segment dark,

with a large round white spot on each side in front. Antennae, legs, anal valves and preanal scale light colored.

Head with the eye cluster small, circular, the 16 to 20 ocelli large, distinctly convex, and arranged in 5 rows. Median furrow usually obsolete, when present only faintly visible in the clypeal region. Clypeus with 3 or 4 fovea on each side.

First segment with the sides narrowly rounded and with a fine raised rim extending from opposite the middle of the eye around the side to the posterior margin; sides above the lateral margin frequently with 1 or 2 short rudimentary striae proceeding forward from the back margin.

Ensuing segments with none of the sutures impressed, although occasionally showing in the body-wall as light lines. Segments of the anterior half of the body crossed by a transverse constriction in the midbelt, containing an impressed sulcus, especially definite on the first 10 or 12 segments, and with rudiments of the ventral striae carried nearly to the pores. On the posterior half of the body the sulcus becomes obsolete and the constriction is much less evident, and does not cross the dorsum of the last few segments. The posterior half of the anterior segments is strongly convex. Pores small, in the usual position half way between the constriction and the posterior margin. Surface of the segments smooth and very strongly shining, without any fine aciculations showing. Ventral striae not extending beyond the tips of the legs, except on the first segments.

Last segment with the apex broad but abruptly rounded, subangulate, not exceeding the summit of the valves. Valves moderately convex, not margined. Preanal scale comparatively short, almost evenly rounded from side to side and without lateral emarginations.

Males with none of the coxae or other joints of the pregenital legs furnished with lobes, the mesial corners of the coxae of legs 3 to 7 a little more prominent than in the females.

Ventral crest of the seventh segment of the males high and thin at the middle, the anterior margin broadly and deeply emarginate from side to side.

Gonopods as shown in figure 19, *a*, *b* and *c*.

Microspirobolus lineatus Chamberlin

Microspirobolus lineatus Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 209, 1918.

Collected at Carrefour, Riviere Froid, July 3, 1927, C. & L.; and at Diquini, the type locality, June 27, 1927, L.; Kenscoff, June 24, 1934, L.

In addition to the characters given in the original description the following points were noted.

The clypeal fovea usually 3 on each side instead of 2 as stated.

Sutures between the 3 belts of the segments not impressed, the transverse sulcus, apparently crossing the midbelt, strongly impressed above and on the sides, dividing the segments into 2 subequal parts, the posterior part somewhat convex, lateral suture impressed behind the transverse sulcus; pore located half way between the sulcus and the posterior margin, above the lateral suture, which it usually touches on the anterior segments but above which it is considerably removed on the middle and posterior segments.

Anal valves evenly convex, not at all margined. Preanal scale rather long, broadly and evenly rounded from side to side.

Seventh segment of the males with a thin ventral crest moderately elevated, the anterior margin at the middle broadly and rather deeply emarginate.

None of the anterior male legs have conspicuous lobes on the coxae or other joints.

The gonopods have been figured by R. V. Chamberlin in the Proc. U. S. Nat. Mus., **61**, Art. 10, 1922, Pl. 4, Fig. 5 & 6.

Microspirobolus furcianus new species

A male (type) and three females collected near Furcy on Mt. Noir, at 6,100 feet elevation, Aug. 21, 1917, C. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Resembling *M. lineatus* Chamberlin but larger in size and with the first four segments dark colored. The deeply grooved median plate and simple hooked inner piece of the gonopod are not found in the other species.

Description. Largest female 30 mm. long and 2.3 mm. broad, with 41 segments; the male broken but about 22 mm. long and 1.8 mm. broad, with 39 segments.

In alcohol the head, first four segments and the last segment dark; on the other segments the sides are dark to just above the pores above which the dorsum is yellow with a broad, moniliform median dark line extending from segment 5 to the penultimate segment, the dark median area on each segment at least twice as wide in front as on the posterior part; hind margin of all segments, except the last, narrowly transparent yellow.

Head with the eyes composed of 17 to 19 medium sized, convex

ocelli in 4 or 5 series; median furrow showing only on the clypeus; clypeus with 4 fovea on each side.

First segment with the anterior lateral corner forming a rounded right angle or slightly less, the lateral margin straight to the posterior corner which varies from being nearly a right angle to a much more obtuse one depending upon the angle of the anterior corner, as when it is sharp the posterior angle is obtuse; raised rim extending from behind the eye to the posterior corner.

Ensuing segments with none of the sutures impressed between the three divisions (forebelt, midbelt and hindbelt) but showing as light lines in the body-wall after the specimens dried somewhat. There

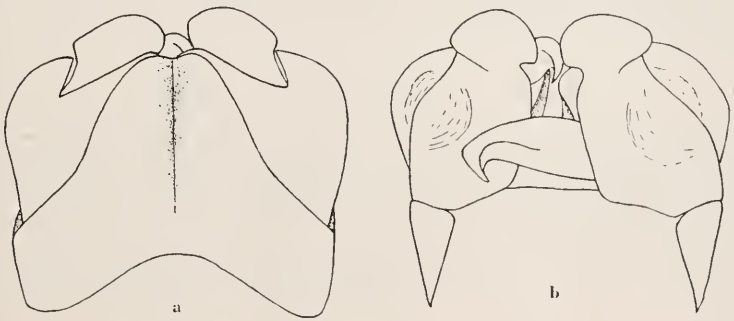


Fig. 20. *Microspirobolus furcianus*. *a*, Gonopods, anterior view; *b*, Gonopods, posterior view.

is a strong transverse median constriction across the segments containing a deep sulcus on all except a few of the posterior segments; surface behind the constriction definitely convex, the pore half way to the posterior margin; surface of the dorsum shining, but magnification shows fine reticulations.

Last segment with apex moderately broadly rounded. Valves meeting in a deep groove and not margined; preanal scale quite long and rather abruptly rounded at the apex.

Gonopods as shown in figure 20, *a* and *b*, the median plate very deeply grooved at middle.

First and second male legs with the 5 outer joints distinctly thicker than on succeeding legs; coxae of the fourth legs with a prominent inner corner, but not forming a definite lobe; none of the other coxae with prominences.

Male with the median ventral crest of the seventh segment high and thick throughout, margining the deep excission in which the tips of the gonopods rest.

Microspirobolus sigillatus Loomis

Microspirobolus sigillatus Loomis, Smiths. Misc. Coll., **89**, no. 14, pp. 20 & 21, 1934.

Morne Pilboreau is the type locality. It has also been collected at the Citadel.

Trigoniulus Pocock

The characters given in the generic description are sufficient to identify the single Hispaniolan species.

Trigoniulus lumbricinus (Gerstaecker)

Spirobolus lumbricinus Gerstaecker, Gliederthier-fauna Sansibar, p. 516, 1873.
Spirobolus goesi Porath, Bih. Svensk. Vet.-Akad. Handl., **4**, no. 7, p. 36, 1876:
Spirobolus dominicae Pocock, Ann. Mag. Nat. Hist., ser. 6, **2**, p. 481–483, 1888.
Spirobolus sanctae-luciae Bollman, Proc. U. S. Nat. Mus., **11**, p. 214, 1888.

This is one of the most common millipeds in Hispaniola and is known from 6 other West Indian islands and the north coast of South America. It is frequently seen about houses crawling on shaded walks or stone walls.

Collected at Port-au-Prince, Petionville, Diquini, Grande Riviere, Ennery, Limbe, Bayeux, and Cape Haitien.

Leiocricus New Genus

Type. *Leiocricus diversipes*, new species.

Diagnosis. The small size and lack of scobinae indicate relationship with *Cubobolus* but the gonopods show very striking differences, and the lack of striae on the forebelt also is significant.

Description. Antennae not reaching beyond the posterior margin of the first segment; sense cones 4. Clypeus with 2 foveolae on each side.

First segment broadly rounded on the sides, weakly margined below the eyes.

Second segment prominent below segment 1, the ventral surface concave. Forebelt of segments smooth, without any transverse

striae above or below. Pores in front of the conspicuously impressed transverse suture, above the middle of the body as viewed from the side.

Gonopods with the basal portion of the ventral plate short and very broadly transverse with a deep, semimembranous, subreniform depression on each side, with the emargination upward; the upper edge of the transverse basal portion on each side slightly covered by the lower part of the anterior lobe; upper portion of the plate a third as wide as the basal portion, with the sides converging distad to a rather narrowly rounded apex. Anterior lobes subquadrate, their upper, outer corners higher than the inner ones. Posterior lobes subtriangular, concave, the apical corner of each lobe thin and bent back and out. Inner gonopods terminating in a bifurcate arm, the branches subequal, long and slender, almost acicular, divergent; some distance below the bifurcation a simple bladelike branch curves up and inward from the outer side of the gonopod, the apex equalling the tips of the upper branches.

Pregenital legs of the male notably stouter than those that follow, the last joint simple beneath; coxae of legs 3, 4 and 5 produced up and back into long, slender lobes. Ventral anterior margin of segment 7 not elevated or specially excavated at the middle in front for the reception of the tips of the gonopods.

Leiocricus diversipes, new species

Collected at the top of Morne Pilboreau, between Ennery and Plaisance, May 24, June 13, (type), and July 8, 1927, L.; near Cancoque, May 13, 1927, L.; Le Brande, July 7, 1927, C. & L., Le Borgne, March 26, 1930, J. & C. Type in U. S. N. M. Paratype in M. C. Z.

Largest specimen, a male, 45 mm. long and 4.2 mm. wide, with 48 segments; all the other specimens have between 41 and 44 segments inclusive.

Living color not noted; in alcohol each segment is nearly black with most of the hindbelt light brown.

Head with the eye-cluster small, circular, composed of about 22 ocelli in 6 rows. Antennae not extending beyond the posterior margin of the first segment. Clypeus with 2 fovea on each side, emargination shallow. Median sulcus weak between the eyes, moderately impressed on the clypeus, no transverse wrinkles between the eyes.

First segment laterally broadly and evenly rounded, with a very narrow raised margin not quite reaching to the eye.

Second segment considerably exposed below the first segment and with a rounded anterior corner; ventral surface slightly concave.

Transverse sulcus very distinct on the back and sides of the anterior segments; the hindbelt strongly convex but the actual margin thin; midbelt somewhat less convex. On the posterior half of the body the transverse sulcus is less distinct above and on the sides, and the mid-

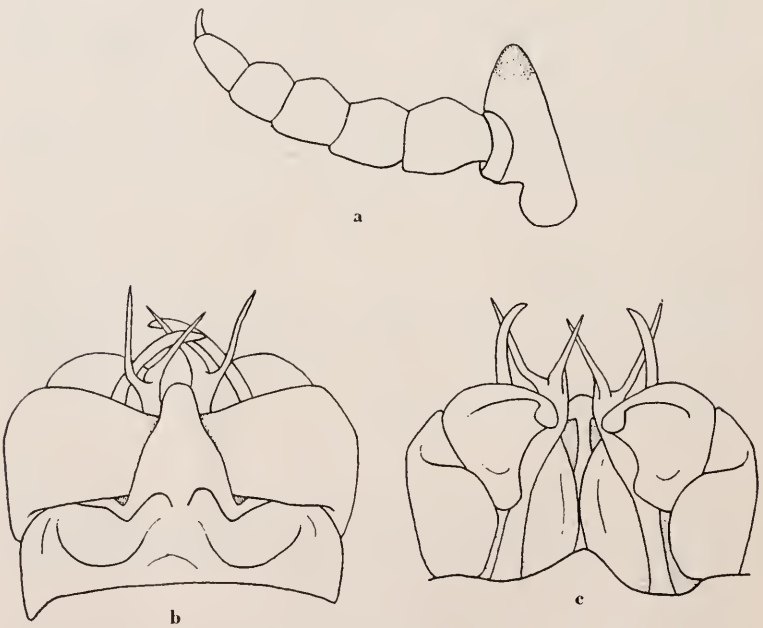


Fig. 21. *Leiocricus diversipes*. *a*, Fourth male leg, posterior view; *b*, Gonopods, anterior view; *c*, Gonopods, posterior view.

and hindbelts are flatter, and on the final segments the sulcus is scarcely visible. Pores rather small, located just in front of the sulcus which usually is straight and continuous opposite the pore. Lateral sulcus not usually impressed or visible on either the mid- or hindbelts. Surface of the segments shining, with a few short, shallowly impressed longitudinal scratches scarcely visible except adjacent to the transverse sulcus; the posterior half of the hindbelt strongly shining. Forebelt smooth, without any of the usual transverse striae either above

or below. Ventral striations of the mid- and hindbelts extending to the ends of the legs.

Last segment with apex short but rather suddenly rounded, exceeded by the anal valves, which are broad, moderately convex and with the margins continuous with the sides, not raised or thickened. Preanal scale less acute than the apex of the last segment, the sides usually inconspicuously and shallowly emarginate.

Males with the pregenital legs notably more robust than the others; the last joint simple beneath, lacking the swollen pad. Coxae of legs 3, 4 and 5 produced into long, rather slender, triangular lobes directed somewhat caudad, especially on legs 3 and 4 which have the longest lobes; under high magnification the distal portion of the lobes appear minutely seabrose (Fig. 21, *a*); coxae of legs 6 and 7 not produced.

Seventh segment of male not crested below but flat and quite long in the middle line, the entire front margin broadly and shallowly emarginate but without special recesses for the tips of the gonopods.

Gonopods as shown in figure 21, *b* and *c*.

Cubobolus Chamberlin

The members of this genus outwardly resemble *Rhinocricus* but they have no scobinae. The ventral plate of the gonopods is somewhat narrowed above the middle but not remarkably so as in *Leiocricus* or *Nesobolus*. The tips of the anterior lobes of the gonopods of *C. cinchonanus* Chamberlin, a Jamaican species, are shown exceeding the end of the ventral plate, and completely hiding the posterior lobes.[1]

Cubobolus rarior (Chamberlin)

Rhinocricus rarior Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 187, 1918.
Cubobolus rarior Chamberlin, Proc. U. S. Nat Mus., **61**, Art. 10, p. 10, 1922.

This species is known from only the original collection at "Grand Riviere." This is probably the Grande Riviere, near Jacmel.

Cubobolus consutus new species

A single female collected at Le Brande, July 7, 1927, C. & L. Type in U. S. N. M.

Diagnosis. The striate transverse sulcus of the segments, and the decidedly transverse last segment sufficiently mark this species to

[1] Proc. U. S. Nat. Mus., **61**, Art. 10, 1922.

justify a description dependent solely on a single female. When males are examined it is entirely possible the assignment of the species to Cubobolus will be found erroneous but no other genus appears to be available at present and the erection of a new genus based on external characters alone is not advisable.

Description. Body 66 mm. long and 6.5 mm. wide. Number of segments 47.

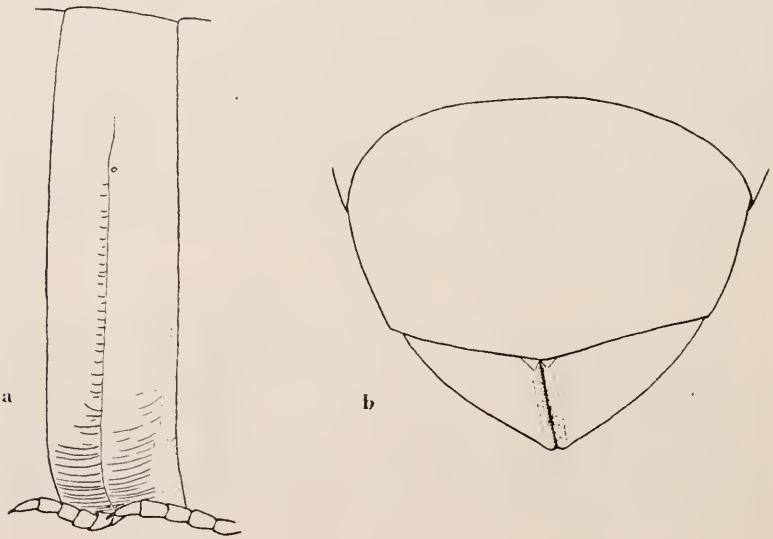


Fig. 22. *Cubobolus consutus.* *a*, Segment from near middle of body, lateral view; *b*, Last segment and valves, oblique posterior view.

Living colors very dark gunmetal, the posterior margins of the segments very narrowly light colored, almost white; first segment narrowly bordered with white throughout; labral region of the head, antennae, legs and ventral surfaces colorless. With a hand lens the suture between the fore- and midbelt is seen to be areolate above the level of the pores and the suture between the mid- and hindbelt is areolate below the pores.

Head with the eyes rounded, composed of about 30 ocelli in 7 rows. Antennae short, reaching the posterior margin of segment 1. Clypeus with 2 setae on each side, the emargination quite deep but much less than a right angle. Front with the median sulcus strongly impressed

on the clypeus, less so between the bases of the antennae; a deep furrow curving forward and inward from the front of each antennal socket but not reaching the median sulcus.

First segment with the sides broadly, evenly rounded, and with a raised rim extending from the lower part of the eye around the lateral margin almost to the posterior margin, the rim broadest along the anterior margin and narrowed on the lateral margin.

Second segment with a prominent, rounded angle below the side of segment 1; ventral surface rather deeply concave and very strongly striate.

Ensuing segments with the transverse sulcus scarcely evident above the pores except on the most anterior segments; below the pores the sulcus is pronounced and the ventral striae, which cross the hindbelt for some distance beyond the tips of the legs, are continued in the sulcus as short rudiments, resembling stitches, all the way to the pore on all of the segments (Fig. 22, *a*). Lateral sutures not impressed on any of the segments. Pores high on the sides of the body, just in front of the sulcus. Forebelt with extremely fine, moderately long transverse striae, usually branching from each other. Mid- and hindbelt not strongly shining, very minutely reticulated with the customary fine, short, acicular scratches. Posterior margin of the segments moderately thickened, scobinae absent.

Last segment almost transverse, the apex scarcely at all produced; exceeded by the anal valves which are broad, nearly flat, the margins indistinctly raised (Fig. 22, *b*). Preanal scale nearly three times as broad as long, the apex suddenly but bluntly rounded, the sides slightly emarginate near the lateral angles.

Legs short, the pairs scarcely half as long as the diameter of the body. Pleurae noticeably broader than long, with strongly evident transverse striae.

Cubocricus Chamberlin

This genus was separated from *Rhinocricus* on the basis of the inner or posterior gonopods being slender and simple, instead of bifurcate; antennal cones numerous; and the anterior legs of the males having a swollen pad on the under side of the terminal joint. The species are of large size, with the body from 10 to 12 times as long as broad.

A single species, of which no specimens were examined, appears to represent this genus in the island.

Cubocricus haitensis (Gervais)

Julus haitensis Gervais, Ins. Apteres, **4**, p. 191, 1847.

The length given for this species is 163 mm. and the breadth 13 mm.; the number of segments 54.

This large and unusually slender spirobolid could not be confused with any of the other members of the family thus far known from Hispaniola. It seems not to have been reported since it was described, and the present collection contains no specimens of it.

Alcimobolus new genus

Type. *Alcimobolus angustipes* new species.

Diagnosis. Many characters associate this genus with *Cubocricus,* but the much smaller size, short, thick body; and the peculiar long, narrow gonopods of the present genus are instantly recognized differences.

Description. Body of medium length but relatively stout, only about eight times as long as wide. Legs short and not visible from above.

Head with two clypeal fovea on each side; antennae rather short and slender, widely separated; sense cones numerous.

First segment laterally rounded, with a very short marginal furrow well below the eye.

Second segment rounded beneath the first segment.

Ensuing segments without any impressed sutures and no definite transverse constriction; ventral striae fine and not extending opposite the ends of the legs; scobinae present.

Last segment surpassed by the anal valves, which have raised and thickened margins.

Gonopods with the ventral plate strongly constricted below the middle; anterior plates long and narrow, the acute distal ends much exceeding the ventral plate; posterior plates thin, very long and narrow, with sides nearly parallel to the broadly rounded, slightly hispid apex; the plates curving caudad with the outer portion apparently carried outside the body; inner gonopods simple, long and very slender.

Coxae of the third male legs produced into small lobes; similar smaller lobes on several of the ensuing legs. Outer joint of all male

legs except the first two pairs and a few pairs at the posterior end of the body with inflated ventral pads.

Alcimobolus angustipes new species

Two males and one female from San Lorenzo, Samana Bay, Dominican Republic, April 6, 1934, Dr. Thomas Barbour. Type and Paratype in M. C. Z.

Length from 56 to 62 mm., width from 7.5 to 8 mm. Number of segments 44 and 45.

The color of the two months old alcoholic specimens is dark olive green, the posterior margins of the segments almost black.

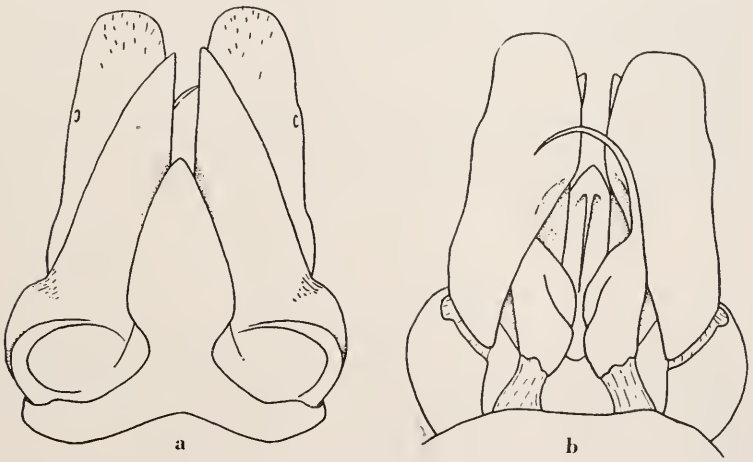


Fig. 23. *Alcimobolus angustipes*. *a*, Gonopods, anterior view; *b*, Gonopods, posterior view.

Head smooth and strongly shining throughout, with a very faint sulcus on the vertex and another on the clypeus. Antennae separated by a distance about equal to the length of the four basal joints.

First segment polished throughout; broadly rounded on the sides, with a furrow for only a very short distance along the anterior lateral margin, its upper limit separated from the lower corner of the eye by about the length of the furrow.

Other segments without any transverse constriction or any impressed sutures, either across the dorsum or along the sides near or behind the pores. Forebelt crossed by a few irregular, discontinuous,

transverse striae; midbelt finely but definitely coriaceous; hindbelt coriaceous in front but brilliantly shining at the posterior margin; ventral striae fine and not reaching opposite the tip of the legs. Pores surrounded by a faintly elevated, flattened ring; the pore on segment 6 set far below the level of the other pores and surrounded by a larger ring. Scobinae present to about segment 21; composed of a long, very narrow transverse pit, followed by a short, broadly triangular striate area.

Last segment very densely and finely coriaceous, much more so than any other segment; apex slightly produced but exceeded by the anal valves.

Anal valves similarly coriaceous, except the raised margins which are strongly shining.

Preanal scale rounded-angular at apex, quite long; nearly smooth behind.

Coxae of third male legs produced into small, sharp, conic lobes; the ensuing legs with coxae decreasing in size.

Gonopods shown in figure 23, *a* and *b*.

Nesobolus Chamberlin

This genus was erected to accommodate those species previously referred to *Rhinocricus* having scobinae; 4 sense cones on the antennae; gonopods with the distal half of the ventral plate elongated and much narrower than the basal portion; inner gonopods with two slender prongs, the outer one exceeding the inner one in length.

Key to the Hispaniolan species of Nesobolus

Body 12 to 14 times as long as broad, slightly compressed laterally; number of segments 58 to 60 ..... *indus* (Beauvois)

Body about 10 times longer than broad and not noticeably compressed laterally; segments 47 to 52 .....

Body seldom exceeding 80 mm. in length; preanal scale triangular; ventral plate of gonopods with the apical portion less than half as wide as the basal portion ..... *maltzani* (Pocock)

Body about 90 mm. long; preanal scale rounded behind; ventral plate of the gonopods triangular, with the apex rounded .....
domingensis (Pocock)

Nesobolus indus (Beauvois)

Julus indus Beauvois, Ins. d'Afr. et d'Amer., p. 154, 1805.
Spirostreptus indus (Pocock), Jour. Linn. Soc., **24**, p. 506, 1894.
Orthoporus (?) *indus* (Chamberlin), Bull. Mus. Comp. Zoöl., **62,** p. 184, 1918.
Numerous specimens collected in 1927, C. & L., 1930 and 1934, L. at Port-au-Prince; Petionville; Kenscoff; Carrefour; Riviere Froid; between Mirogoane and Petit Goave; Trouin; and at Concoque, between Limbe and Ennery. Port-au-Prince, Oct. 1934, P. J. Darlington.

There can be little doubt that these specimens represent the species Beauvois described as *Julus indus* from Santo Domingo. It is obvious that the species really belongs in the *Spirobolidae* and must now be removed from the *Spirostreptidae,* in which Pocock and others placed it without examining specimens.

Pocock's supposition that *Julus beauvoisi* Gervais, from Martinique, is distinct from *N. indus* doubtless is correct, but neither of these species has been reported from Martinique since 1847, and specimens from there must be seen before the question can be settled. However, until this is done it seems advisable to consider *Nesobolus* (*Julus*) *beauvoisi* as a distinct species on purely geographic grounds.

The following description has been prepared to put *N. indus* on the same taxonomic basis as other West Indian spirobolids, and to allow the identity of the confused Martinique form to be more easily determined when specimens are found.

Description. Body very long and slender, 12 to 14 times longer than broad; the largest specimen, a female, is 82 mm. long and 6.5 mm. broad. Body slightly compressed laterally, being higher than broad when seen in cross section; and tapering very gradually at both ends, especially behind, beginning 10 or 12 segments from the end. Number of segments 58 to 60. Head small, the front strongly convex; median sulcus impressed near the clypeus but not elsewhere. Eyes circular, composed of 26 to 29 ocelli in 7 rows. Antennae short, scarcely reaching the posterior margin of segment 1; sense cones 4. Clypeus with 2 setae on each side.

First segment long, the sides a little above the lateral margin abruptly clasping the second segment and the sides of the head. Lateral margin elongate, subangulate before and behind and with an exceedingly short, narrow raised margin not reaching the eye.

Second segment with a prominent, broadly rounded corner beneath segment 1 and with a deep, triangular ventral depression on each side, containing strong longitudinal striae.

Segments without any suggestion of a transverse constriction on the dorsal, lateral, or ventral surfaces and the sulcus not impressed except occasionally for a very short distance close to the pore; lateral sulcus infrequently impressed on the hindbelt, never impressed on the midbelt; the posterior margins of the segments very thin; pores small, high on the sides in a shallow depression. Surface of the segments with

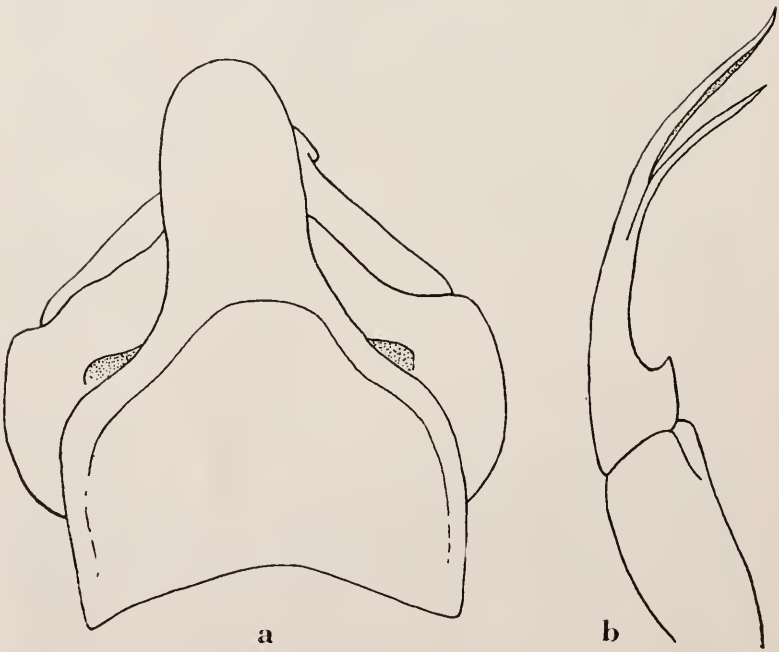


Fig. 24. *Nesobolus indus*. *a*, Gonopods, anterior view; *b*, Inner gonopod, lateral view.

very short, straight, fine scratches, not apparent close to the posterior margin. Ventral striae greatly exceeded by the legs. Scobinae usually beginning on segment 8 and sometimes ending as far back as the 27th segment; represented by very large, flat, transversely oval dull areas surrounded by the striae of the forebelt.

Last segment rounded at apex, exceeded by the anal valves which are flattened on the outer side but not at all margined. Preanal scale long, the apex similar in shape to that of the last segment.

Legs of both sexes extremely short and quite slender, the pairs only about equal to two-thirds the diameter of the body; sterna longer than broad and with 12 to 15 distinct transverse striae.

Male legs with a swollen pad on the ventral face of the last joint on the anterior half of the body. The legs in front of the gonopods with no other notable modifications although the coxae of legs 3, 4 and 5 are slightly produced.

Seventh segment of the male with a broad low ventral crest having a deep transverse pocket in the anterior face at middle for the reception of the tips of the lateral lobes of the gonopods, the posterior edge of the crest produced backward, forming a distinct median lip.

Gonopods as shown by figure 24, *a* and *b*.

Nesobolus maltzani (Pocock)

Rhinocricus maltzani Pocock, Jour. Linn. Soc. Lond., **24**, p. 495, 1894.

This species was described from the north coast of Haiti, and Chamberlin has reported it from Furcy, and Jacmel on the Southern coast.[1]

Specimens in the present collection are from Ennery, Le Brande, Plaisance, and Christophe's Citadel, C. &. L.

Nesobolus domingensis (Pocock)

Julus haitensis Saussure (not Gervais), Mem. Soc. Phys. Hist. Nat., p. 363, 1860.

Rhinocricus domingensis Pocock, Jour. Linn. Soc. Lond., **24**, p. 495, 1894.

No specimens of this species have been recognized in the present collection and its inclusion in the genus *Nesobolus* is based entirely on Pocock's association of the species with *N. maltzani*. The correctness of this disposition awaits the examination of specimens.

Rhinocricus Karsch

The members of this genus, in its present semi-restricted state, have the antennal cones variable, there being either four or many cones; clypeus with two fovea on each side; first segment with the sides rounded; scobinae present on some of the anterior segments; and the males have the distal branch of the inner gonopods moderately broad and long, the lower branch usually more slender.

[1] Bull. Mus. Comp. Zoöl., **62**, p. 193, 1918.

The Hispaniolan species are distinguished in the following key, which has been divided into two sections, depending on the number of antennal cones.

Key to the Hispaniolan species of Rhinocricus

Last joint of antennae with four sense cones.

Segments with a second transverse sulcus in front of the usual one; last segment with the apex prolonged into a distinct mucro greatly exceeding the anal valves ..... *monilicornis* Porath

Segments with only one transverse sulcus; last segment not mucronate or exceeding the anal valves .....

Transverse sulcus lightly impressed; scobinae without pits, represented by rugose areas only ..... *scobinellus* new

Transverse sulcus deeply impressed; scobinae with pits as well as rugose areas .....

General color black; body moderately slender; margins of the anal valves thick but not elevated ..... *curtior* Chamberlin

General color light cinnamon brown; body slightly stouter; margins of anal valves thin and faintly elevated .. *mediator* Chamberlin

Last joint of antennae with numerous sense cones.

Body very large, exceeding 140 mm. in length and 17 mm. in diameter ..... *lethifer* new

Body small, less than 50 mm. in length and 5 mm. in diameter .....

Body slender, over 12 times as long as thick ..... *albolatus* new

Body about 10 times as long as thick .....

Transverse sulcus strongly impressed on the dorsum and sides of the body ..... *cinctus* new

Transverse sulcus lightly or not at all impressed on the dorsal surface, slightly more strongly impressed on the sides of the body ....

Eyes composed of 16 to 20 ocelli of which the lower ones are much the largest ..... *furcianus* Chamberlin

Eyes composed of 25 or more ocelli, the lower ones differing little from the upper ones in size .....

Color rather light brown; number of segments about 43 .. *ramulus* new

Color nearly black; number of segments 46 to 48 *nigrescens* Chamberlin

Rhinocricus monilicornis (Porath)

Spirobolus monilicornis Porath, Bih. Svensk. Vet-Akad. Handl., **4**, p. 31, 1876.
Spirobolus heilprini Bollman, Proc. Acad. Nat. Sci. Phila., p. 127, 1889.

In addition to Pocock's description it may be noted that the seventh segment of the male has an extremely high ventral crest, with a single

broad and deep recess or pocket in its anterior face for the reception of the tips of the gonopods.

This species has been collected at Cape Haitien, Bayeux, Limbe, and Grande Riviere. It is one of the three or four rather widely distributed West Indian spirobolids, being recorded from six islands, British and Dutch Guiana.

Rhinocricus scobinellus new species

One male collected from the foothills of Morne La Hotte at 4000 feet elevation, Oct. 1934 by P. J. Darlington. Type in M. C. Z.

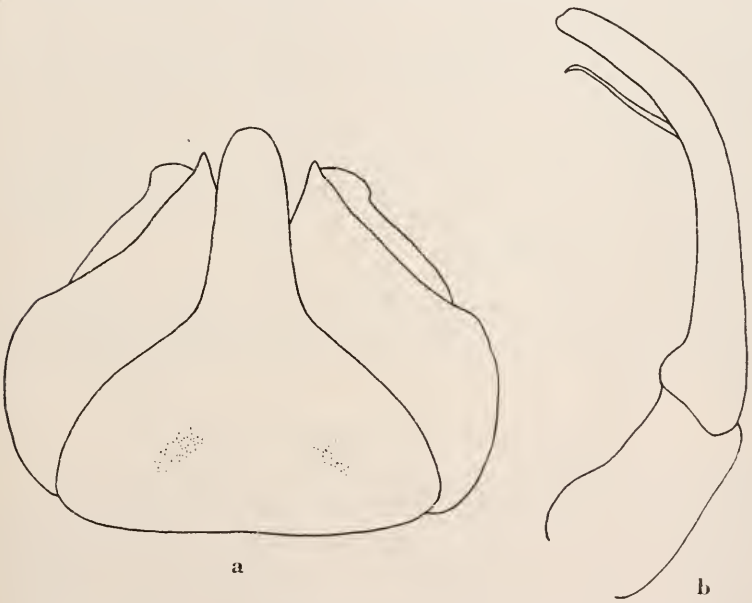


Fig. 25. *Rhinocricus scobinellus. a,* Gonopods, anterior view; *b,* Inner gonopod.

Diagnosis. The transverse sulcus is very faint in contrast to that in *R. curtior* and *R. mediator,* and the unimpressed scobinae is another distinctive character, in addition to which the gonopods show notable differences.

Description. Length 45 mm., width 4.5 mm; number of segments 48. The color in alcohol is dark reddish brown; the sides of the forebelt mottled with light spots; midbelt dark brown; posterior part of the hindbelt light, especially on the sides.

Antennae short and stout, each of the five outer joints broader than long; sense cones 4. Ocelli 36 in 6 series, counting from the back of the head.

First segment with sides broadly and evenly rounded, the raised marginal rim short, scarcely reaching the lower corner of the eye.

Ensuing segments with transverse sulcus lightly impressed on the sides, and still more lightly impressed on the dorsum; lateral sulcus faintly visible behind the pores. Posterior portion of body very gradually narrowed to the narrow last segment. Surface of segments smooth and shining. Scobinae without the usual impressed pits in front of the rugose areas but the rugose areas are present and are large and broadly oval on the anterior segments and separated by a distance less than the cross diameter of one area; further back the size of the areas decreases and none are apparent much behind the middle of the body.

Last segment rather long and narrower than usual, the apex produced backward but not beyond the valves. The valves are but little inflated and the margins are thin but not separately raised. Preanal scale large and long-triangular.

Gonopods shown in figure 25, *a* and *b*.

Male with the coxae of legs 3 to 5 or 6 with distinct conic lobes. Seventh segment with the ventral surface raised and thickened behind the gonopods and with an excavation in the front face to receive their tips.

Rhinocricus curtior Chamberlin

Rhinocricus curtior Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 194, 1918.

The type locality, "Grande Riviere," probably refers to a river on the south coast of the southern peninsula near Jacmel. Many specimens collected in rotting yucca stumps above Kenscoff, June 24, 1934 by E. M. and H. F. Loomis. A mature male collected at Fond des Negre, April 4, 1930, C. One male and two females from foothills of Morne La Hotte, Oct. 1934, P. J. Darlington.

Unless otherwise noted the following remarks refer to the Fond des Negre specimen.

Body 50 mm. long and 5.2 wide.

Transverse constriction of the segments remarkably impressed on the dorsum of the anterior segments but decreasing toward the posterior end of the body and visible only on the sides of the last few segments. Lateral sutures evident only behind the constrictions and directly behind the pores, the sutures stronger on the caudal segments. In the Kenscoff specimens no lateral sutures are anywhere

evident. Scobinae extending onto segment 40; at the middle of the body they are represented by broad, transversely oval, pits, deeper behind, and followed by a larger striate area.

Eyes not separated by more than three times the diameter of one eye; composed of about 32 ocelli in 6 horizontal series, arranged 4, 5, 5, 6, 6, 6, counting downward from the top of the head. Antennal cones 4.

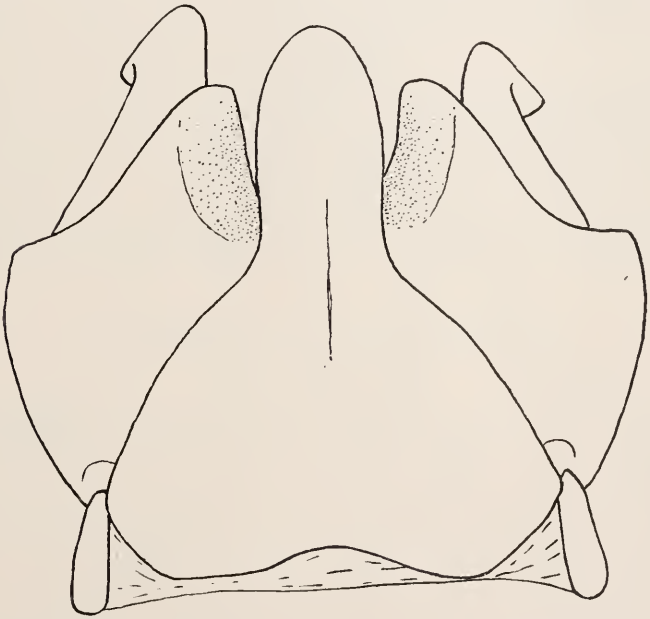


Fig. 26. *Rhinocricus curtior*. Gonopods, with anterior plates somewhat spread apart, anterior view.

Legs in front of the gonopods without special prominences. In the Kenscoff males the coxae of legs 3 to 5 are slightly lobed and all legs, except a few at the posterior end of the body, have a pad beneath the last joint. Legs 3 to 5 of Darlington's male are strongly lobed.

Seventh segment of the male with the ventral anterior margin greatly elevated and produced backward at the middle, the anterior face deeply cupped to receive the tips of the gonopods; the apex of the raised margin forming a high lip over the base of the coxae of the anterior legs of segment 8.

Gonopods as shown in figure 26.

Rhinocricus mediator Chamberlin

Rhinocricus mediator Chamberlin, Bull. Mus Comp. Zoöl., **62**, p. 189, 1918.
This species is known from the original collection at Furcy, and a male and female from Kenscoff, collected June 24, 1934 by E. M. and H. F. Loomis.

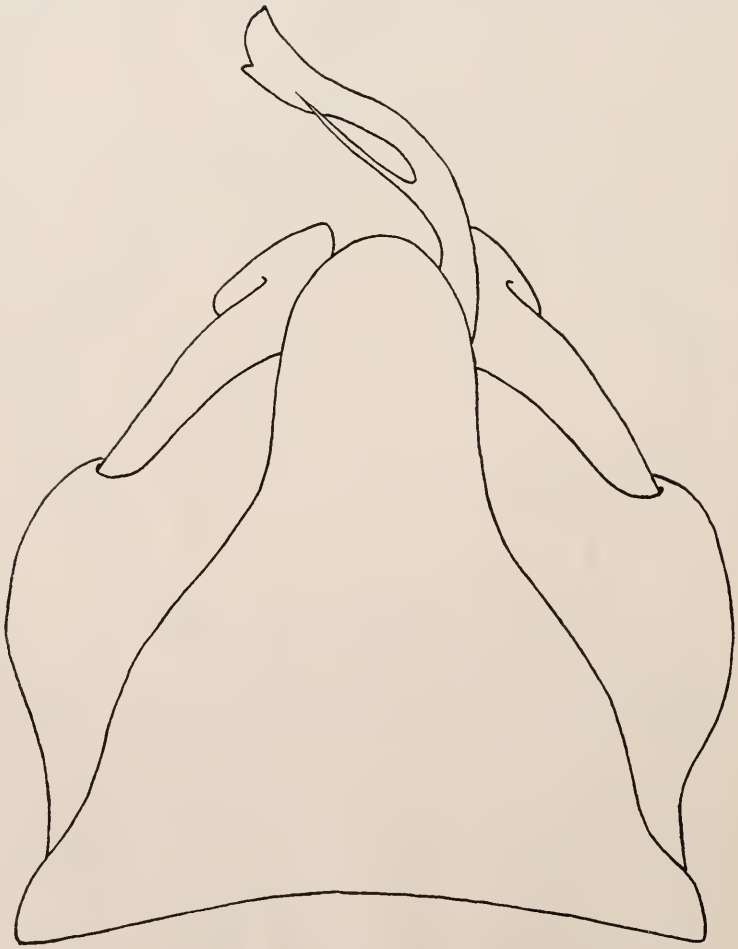


Fig. 27. *Rhinocricus mediator*. Gonopods of paratype, anterior view.

The following notes were made from a paratype male unless otherwise noted.

Number of segments 52.

Eyes circular, composed of about 41 small, uniform, ocelli neatly arranged in 8 longitudinal or 6 vertical series; antennal cones 4.

Posterior border of all segments straight and continuous, not bisinuate above the scobinae as stated in Chamberlin's key.[1] Scobinae round, followed by an elongate-oval striate area. In the Kenscoff specimens the scobinae are transversely oval and are followed by a broadly oval striate area. In these specimens the margins of the segments are straight as in the paratype.

Gonopods of paratype shown in figure 27.

Coxae of legs 3 to 7 somewhat produced, especially on the fifth legs.

Beginning with the third legs and extending to near the posterior end of the body the distal joint of each leg has a swollen pad on the under side.

Ventral surface of the seventh segment greatly elevated, the anterior face with a deep pit at middle to receive the tips of the gonopods.

Rhinocricus lethifer, new species

Plate 1, Fig. 2 & 3

Numerous specimens collected between Petit Goave and Miragoane, June 28, 1927 C. & L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. This is one of the largest of the West Indian millipeds, approximating *Cubocricus suprenans* Chamberlin from Cuba in length and being much thicker. It seems to have no close relatives in the islands and appears more closely allied to the Central American group containing *R. rixi* Pocock and *R. aposematus* Pocock which are of large size and have numerous antennal cones. The structure of the gonopods, last segment and anal valves would indicate relationship with *R. smithi* Pocock but that species has only 4 antennal sense cones and the scobinae extend to about the fourth segment from the posterior end of the body.

Description. Largest female 175 mm. long and 22.5 mm. broad; largest male 152 mm. long and 19 mm. broad. Number of segments 55 to 57.

Color in life deep chestnut brown throughout.

Head with median sulcus deeply and strongly impressed on the vertex, less so on the front and clypeus; transverse lines between the

[1] Proc. U. S. Nat. Mus., **61**, p. 6, 1922.

bases of the antennae faintly impressed; front and clypeus quite smooth and shining, the vertex very coarsely rugose; margin of the corner of the head below the eye with a high thick rim. Eyes subtriangular, composed of 22 to 42 ocelli in 6 or 7 rows, the ocelli large, convex and very evident. Antennae moderately short, reaching little beyond the posterior margin of segment 1; sense cones numerous. Clypeus broadly and shallowly emarginate, with 2 fovea on each side.

First segment rather narrowly rounded laterally, with a raised margin extending from the lower part of the eye around the lateral angle.

Second segment with the anterior corner rounded below segment 1; ventral surface flat or slightly concave, strongly striate.

Ensuing segments with the transverse sulcus moderately evident on the sides, less so on the dorsum, the pore located just in front of it and below the lateral sulcus, which is very conspicuous on the mid- and hindbelt and less so on the forebelt; the pores near the middle of the side of the body, except on each side of segment 6 where the pore is far below the lateral sulcus (Fig. 28, *a*.). Forebelt very finely, transversely branched-striate. Mid- and hindbelts rather coarsely but indefinitely longitudinally rugate, except close to the posterior margin which is somewhat thickened. Scobinae beginning on about segment 8 and continuing to segment 26 or 27. Ventral striae equalling or slightly exceeding the tips of the legs. Pleurae over twice as wide as long and with 10 or 12 striae.

Last segment conspicuously narrowed caudad to an acute apex which equals or somewhat exceeds the summit of the anal valves; surface coarsely punctate, the caudal half very densely so; across the middle of the segment is a broad, indefinitely limited, impression.

Anal valves flattened and with very high, rather thin margins; surface coarsely punctate, the convex sides less densely so than the flat sides of the margins where the punctures are so closely placed that the surface appears extremely rugose. Preanal scale broadly rounded behind, the sides emarginate near the lateral angles (Fig. 28, *b*).

Males with the coxae of the third legs produced into rather broad, thick subconic lobes; coxae of the fourth legs with lobes less produced but nearly twice as broad at the apex and slightly thicker; apex of the coxae of legs 5 and 6 broad but thin and scarcely produced; the coxae of the seventh legs broad and thick, not definitely produced. Apical joint of the anterior legs simple beneath, without a swollen pad.

Seventh segment of male with a somewhat elevated ventral crest, broadly and deeply emarginate at middle, in front; the posterior

margin produced caudad, nearly concealing the sternum of the legs of the eighth segment.

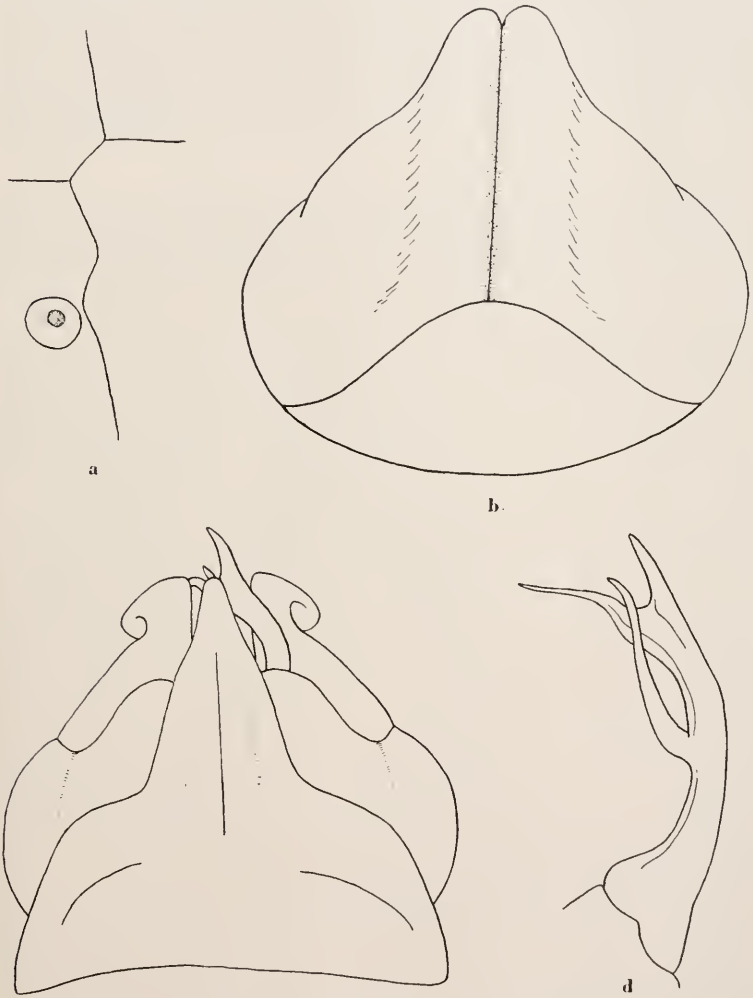


Fig. 28. *Rhinocricus lethifer*. *a*, Sutures and pore on the side of segment 6; *b*, anal valves and scale, ventral view; *c*, Gonopods, anterior view; *d*, Inner gonopod.

Gonopods as shown in figure 28, *c* and *d*.

This is one of the largest millipeds reported from the Western Hemisphere and is the largest member of the genus in the present restricted sense. The members of the family to which it belongs are provided with a disagreeably pungent fluid, which they usually emit in small droplets from a series of pores along each side of the body when disturbed. The caustic properties of this secretion have long been known to collectors, who, after handling the millipeds, have noted that the skin of their hands became discolored and later frequently peeled off in small areas.

Numerous specimens of this species were collected by O. F. Cook and the writer beneath fallen leaves in a wood on the side of a hill. In collecting the first specimens it was noticed that they were able to eject the repugnatorial fluid several inches from the body and that it caused a smarting sensation on the moist skin of the back of the hands and lower forearms, but no particular precautions were taken to avoid the fluid and collecting continued. However, in turning over the leaves, a large specimen was rolled into view on its side among the dead leaves and it instantly ejected its secretion upward a distance of about 18 inches into the face and left eye of the writer. The pain was instantaneous, intense, and of a burning and smarting nature, continuing for several hours in spite of the fact that the face and left eye had been immediately bathed in ice-water to remove the secretion and allay the pain. Swelling of the eyelid and cheek progressed rapidly and soon the eye was closed and remained so for several hours, after which the pain and swelling began to subside. The following morning the pain was gone but the eyelid again was swollen shut. The swelling was rapidly reduced by bathing the eye with cold water as was also necessary the second morning. On the day following the attack the skin of the cheek, forehead and eyelid had turned dark brown and was raised into blisters where the concentration of the secretion had been greatest. The blisters persisted nearly a week, after which the discolored skin peeled off without leaving any scars and no further ill effects were experienced.

Inquiries in the neighborhood elicited the fact that the natives were thoroughly familiar with the ability of this milliped to blind small animals, especially chickens that come upon the millipeds while scratching among the leaves. Chickens thus blinded were said never to recover and usually were killed forthwith by the owner, but where the injured chicken was allowed to die, death probably was caused by starvation rather than by any lethal substance in the repugnatorial fluid.

Insofar as is known this is the first record of injuries of a serious nature being caused to man or other animals by a diplopod.

While the emission of the repugnatorial fluid in pronounced jets is not known to have been reported for other members of the family, the size of many of the animals is sufficiently great to render them dangerous, should they possess the faculty, and they should be handled with care.

Rhinocricus albolatus new species

Seven males and two females collected at Kenscoff, June 24, 1934 by E. M. and H. F. Loomis. Type in U. S. N. M. Paratype in M. C. Z.

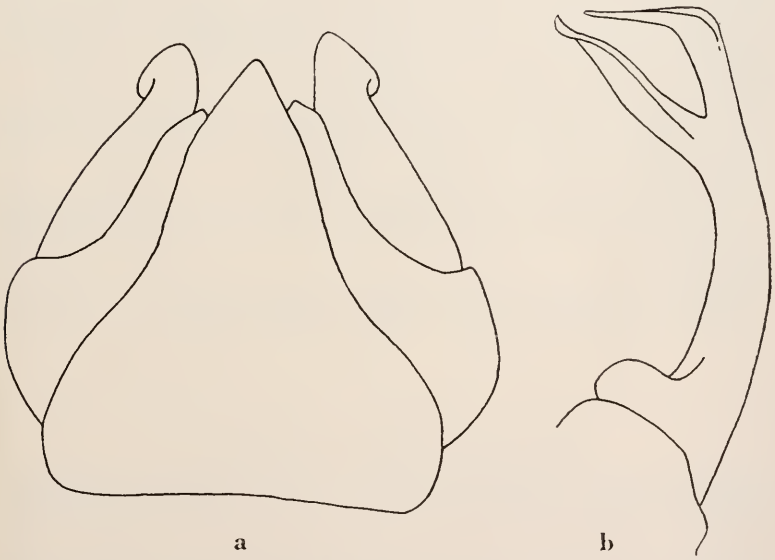


Fig. 29. *Rhinocricus albolatus*. *a*, Gonopods, anterior view; *b*, Inner gonopod.

Diagnosis. Although the gonopods denote closer association with *R. nigrescens* than any other Hispaniolan form now known, the proportions of the body and the almost complete lack of impressed sutures shows that this association is remote. This is the most slender Hispaniolan *Rhinocricus*.

Description. A relatively small and slender species reaching 42 mm. in length and only 3 mm. in maximum diameter. Number of segments 48 or 49.

Living color shining black above; sides below the pores with the posterior portion of each segment white, the remainder of the exposed surface black but maculate with tiny white spots.

Eyes small, widely separated, composed of 16 to 20 ocelli. Antennae with numerous sense cones.

First segment with the impressed marginal furrow short, not quite reaching the lower limit of the eye.

Ensuing segments with transverse sulcus faint on the sides, and seldom evident on the dorsum; no lateral sulcus anywhere evident. Surface strongly shining but with fine, short, longitudinal scratches visible with moderate magnification. Forebelt with annular striae very faint. Scobinae short but very broad, separated by about the diameter of one scobina; each followed by a striate area which is broader than long and rounded behind.

Last segment quite long, acutely pointed but exceeded by the anal valves which are evenly convex and without raised margins.

Gonopods as shown in figure 29, *a* and *b*.

Seventh segment of males with the ventral crest gradually raised from each side and moderately hollowed in front to receive the tips of the gonopods.

Males with the coxae of the pregenital legs unmodified. Terminal joint of all legs simple beneath, lacking inflated pads.

Rhinocricus cinctus new species

Two males collected on Morne La Hotte, Oct. 16–17, 1934 by P. J. Darlington. Type and paratype in M. C. Z.

Diagnosis. Aside from the evident differences of the male gonopods this species may be distinguished from its closest relatives, *R. furcianus* and *R. nigrescens*, by the very strongly impressed sulcus and smaller scobinae.

Description. Length 37 mm. width 3 mm.; number of segments 43 and 45. Body widest at segment 1, rather abruptly narrowed at the posterior end; males with segments 6 and 7 swollen and noticeably broader than the adjacent segments but not as broad as segment 1.

Color of the specimens almost black. Surface shining but with suf-

ficient magnification many fine, short, longitudinal scratches are visible.

Antennae short and stout; sense cones numerous. Eyes composed of 30 to 32 ocelli.

First segment broadly rounded on the sides, the raised margin short, barely reaching the lower corner of the eye.

Principal body segments with the transverse sulcus strongly and equally impressed on the sides and dorsum, curving sharply around behind the pore. Lateral sulcus sometimes slightly evident behind

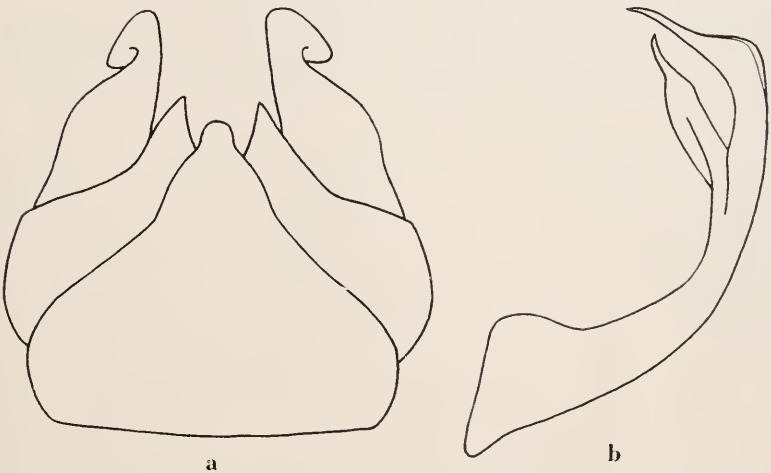


Fig. 30. *Rhinocricus cinctus*. *a*, Gonopods, anterior view; *b*, Inner gonopod.

the pores but not in front of them. Scobinae small, the pits oval-rounded and, on the anterior segments, followed by a rugose area only two or three times as large; on the segments further back the rugose areas decrease to the size of the pits or even smaller.

Last segment rather long, the apex rounded-acute, not exceeding the valves.

Anal valves scarcely inflated on the sides, the rather thin margins not separately raised. Preanal scale large, triangular.

Males with gonopods as shown in figure 30, *a* and *b*.

Males with pregenital legs lacking coxal lobes or pads beneath any of the joints. Seventh segment with the ventral surface elevated at the middle into a ridge which has the anterior face depressed.

Rhinocricus furcianus Chamberlin

Rhinocricus furcianus Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 192, 1918.
Furcy is the type locality.

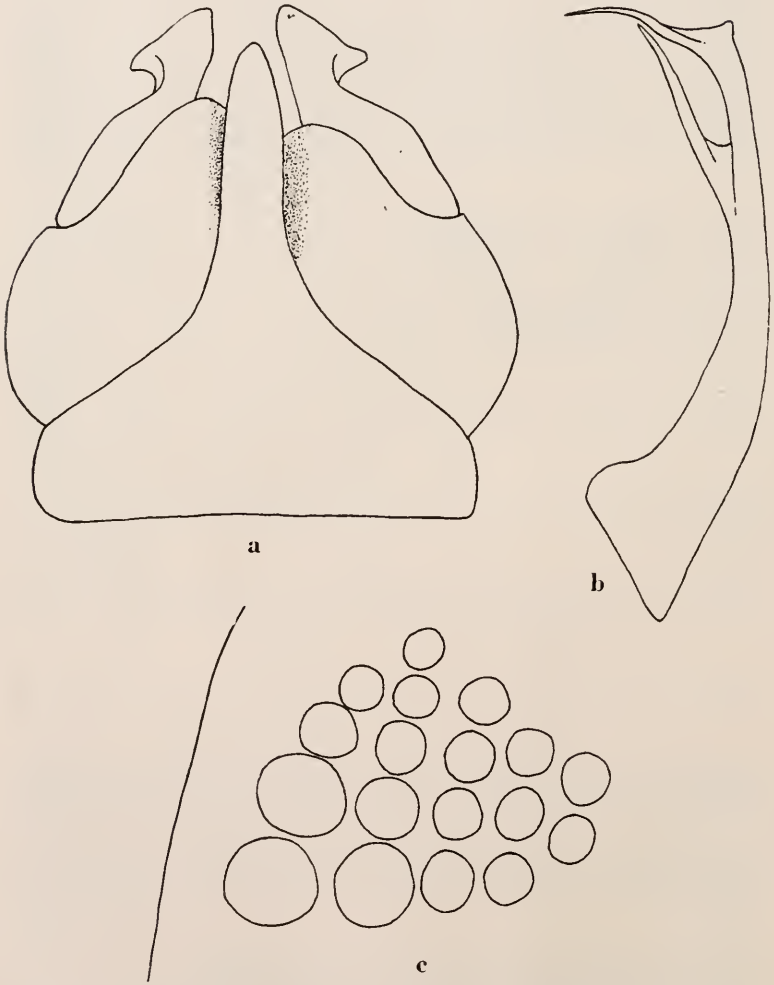


Fig. 31. *Rhinocricus furcianus*. *a*, Gonopods of paratype, anterior view; *b*, Inner gonopod of paratype; *c*, Eye-cluster.

In a paratype male of *R. furcianus* from the Museum of Comparative Zoölogy, the eyes contain 16 ocelli, of which the lower ones are

distinctly the largest. The scobinae are large and shallow and separated by a distance no greater than the width of one of them. The antennal cones are numerous. Gonopods shown in figure 31, *a* and *b*.

The National Museum collection contains 3 female specimens from 6100 ft., Mt. Noir, Haiti, Aug. 2, 1917, C. which appear similar to the paratype male. The eye of one of these specimens is shown in figure 31, *c*.

Rhinocricus nigrescens Chamberlin

Rhinocricus nigrescens Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 195, 1918. Three mature males and two immature specimens collected between Petionville and Kenscoff, June 23, 1934, L. The type locality is Furcy.

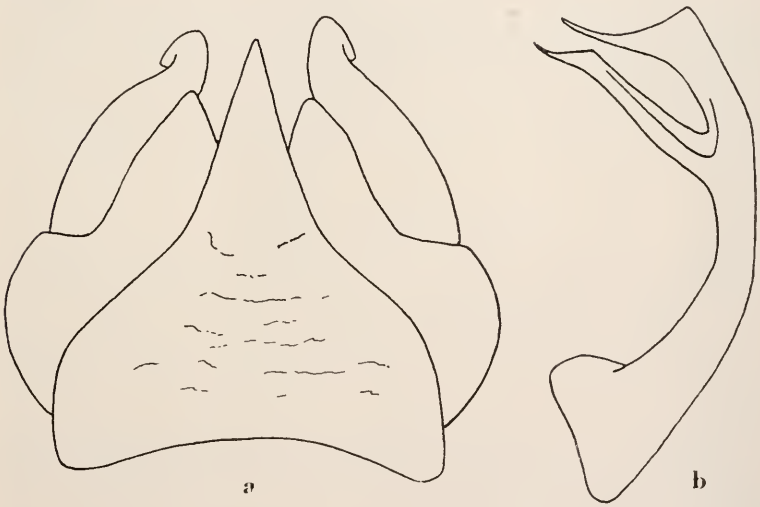


Fig. 32. *Rhinocricus nigrescens*. *a*, Gonopods, anterior view; *b*, Inner Gonopod.

This appears to be a valid species closely related to *R. furcianus* but with more segments, 46 to 48; more numerous ocelli; and different shaped gonopods, as shown in figure 32, *a* and *b*. The transverse sulcus is prominent on the sides of the body but does not cross the dorsum except very faintly on a few anterior segments. The scobinae are much the same as in *R. furcianus* but are deeper. Antennal cones numerous.

Rhinocricus ramulus new species

One male collected at Roche Croix on Morne La Hotte at 5000 feet elevation, Oct. 13, 1934 by P. J. Darlington. Type in M. C. Z.

Diagnosis. The conspicuous peculiarities of this species are the slender antennae with fewer cones than other species in the group with numerous cones; and the long and very slender upper branch of the inner gonopods.

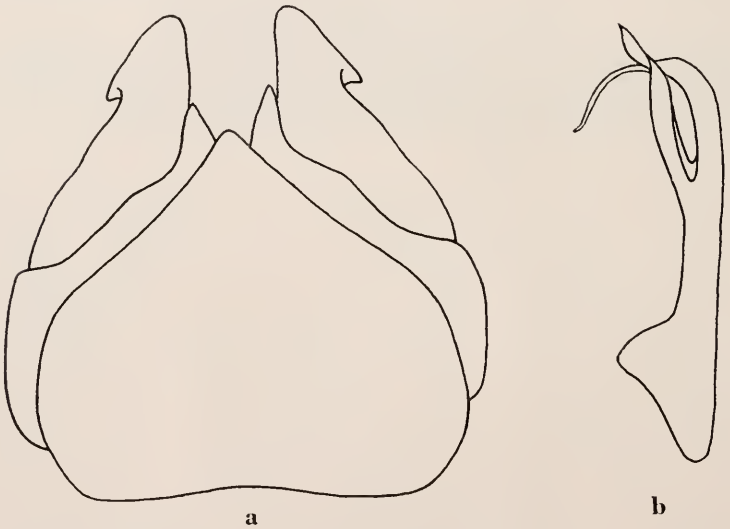


Fig. 33. *Rhinocricus ramulus. a*, Gonopods, anterior view; *b*, Inner gonopod.

Description. Length 31 mm., width 3.5 mm. Number of segments 43. Body of uniform width from the first segment to within about seven segments of the posterior end.

Color of the alcoholic specimen light brown above, the sides adjacent to the pores and below them with lighter mottlings on the fore- and midbelts. First segment with a large transverse area of light maculations on each side of the middle.

Antennae quite slender for a species having numerous sense cones although the number of cones is less than in any other Hispaniolan species in the group, being about 12. Ocelli 25 to 29. Cardo of the mandibles with a prominent tooth at the lower anterior corner.

First segment rather narrowly rounded on the sides, the raised rim reaching somewhat above the lower corner of the eye.

Segments not constricted and with the transverse sulcus very faint on the sides of the body and still more so on the dorsum. Lateral sulcus lightly impressed behind the pores. Scobinae with the pits short but broad and deep, rather narrowly separated, followed by a subrectangular rugose area about as long as wide. Surface of segments shining, but very fine, short aciculations are evident under strong magnification.

Anal valves definitely and evenly inflated on the sides; the margins not separately raised.

The gonopods, as shown in figure 33, *a* and *b*, have the median plate more definitely cordate than in closely related species, and the upper branch of the inner gonopods is unusually long and more slender than in any other member of the genus.

Seventh segment with the ventral surface elevated at the middle into a conic prominence or ridge which is slightly concave on its front face.

The pregenital legs of the male lack coxal lobes or pads beneath the outer joints.

Order MEROCHETA

This order contains considerably more species than all the six other orders of millipeds found in Hispaniola combined. The species range from moderately sized, strongly armored animals, to very minute, delicate creatures, almost without color. Some of the larger species are handsomely colored, and show striking differences in the coloration of the segments which bear the repugnatorial pores, and those which do not. While the number of segments is limited to 18, 19 or 20, the structural variations that occur in this order show a range that is without parallel in any other order of millipeds. Eight families, one of them described for the first time, have been found in Hispaniola, and are characterized in the following key.

Key to the Hispaniolan families of Merocheta

Body short and broad, with carinae making a continuous descent from the highly arched dorsum; third segment greatly enlarged, the ones that follow have narrow carinae specialized to allow rolling into a ball for protection ..... *Cyclodesmidae*

Body remaining extended or coiled in an open spiral, not capable of being rolled into a ball; carinae usually not making a continuous descent from the dorsum, but extending away from it horizontally or obliquely .....

Dorsum narrow, with large, strongly ascending, thickened and knobbed carinae ..... *Eoromidae* new

Dorsum broader, the carinae horizontal or descending, and with thinner margins .....

Last segment small and completely hidden from above by the penultimate segment ..... *Hercodesmidae*

Last segment larger and visible from above, beyond the penultimate segment .....

Body very strongly convex; carinae strongly depressed or set low on the sides of the segments; repugnatorial pores on special tubercles at the posterior corners of the carinae . . *Stiodesmidae*

Body with the dorsum less convex, sometimes nearly flat; carinae usually high on the sides of the segment and more nearly horizontal; repugnatorial pores not on special tubercles on the margin of the carinae .....

Body compact, the anterior subsegments not exposed above; first segment concealing the head and antennae from above, the anterior part with 12 convex areas; lateral carinae projecting and hiding the legs, with 3 or 4 marginal, convex areas .....
Chytodesmidae

Body rather loose-jointed, the anterior subsegments exposed above; first segment not concealing the head and antennae, the anterior part without definite, convex areas; lateral carinae projecting less, not completely hiding the legs, and without marginal, convex areas .....

Body with the dorsum nearly flat, surface somewhat setaceous, sometimes tuberculate or with distinct, convex areas; lateral carinae projecting nearly at the level of the back, the margins not thickened; repugnatorial pores usually on the dorsal surface of the carinae ..... *Polydesmidae*

Body with the dorsum distinctly convex, smooth, and without definite, convex areas, lateral carinae at least slightly lower than the back; repugnatorial pores borne laterally in the thickened margin of the carinae .....

Second segment with each lateral carina lower than the lateral margins of the first and third segments and projecting forward beneath the angle of the first segment ..... *Strongylosomidae*

Second segment with the lateral carinae smaller, not projecting forward beneath the angles of the first segment, the margins continuous with those of the first and third segments . . . . . *Chelodesmidae*

Family CYCLODESMIDAE

The family *Cyclodesmidae* has, till the present, been represented by a single genus containing a small number of species from several West Indian islands. The species reported in this paper more than double the known forms but unquestionably there are many undiscovered species in Hispaniola and some of the other islands. The species bear such great superficial resemblance to each other that possibly they may not have been collected as assiduously as millipeds with more striking differences. In the majority of species it has been found that the only satisfactory means of identification was by examination of the gonopods, with differences of size, coloration, surface sculpturing, segment shape, etc., seldom solely sufficient for purposes of classification.

While the individual Hispaniolan species are very restricted in distribution it is usual to find some members of the family in nearly every suitable location and the family offers an interesting opportunity for the study of distribution and evolution, but a better knowledge of the members, through extensive collecting in the unexplored parts of the island, first will be necessary.

In the material studied for this paper there were four species with several external characters so different from those prevailing in the genus *Cyclodesmus* that they appeared to form a natural group for which the new generic name *Lophocyclus* is proposed in reference to the large ridge on each side of segment three, the outstanding difference from *Cyclodesmus*.

The characters previously credited to this family require some amplification to allow the inclusion of the new species, as those which have erect setae on the surface of the segments, a prominent ridge on each side of segment three, or distally truncated carinae on segment 4.

Cyclodesmus Humbert & Saussure

Most of the species have a smooth, shining surface entirely devoid of erect setae, and usually are found in the leaf mould, rolled into a compact ball for protection when they may easily be mistaken for pillbugs. When thus rolled the enlarged third segment conceals the

head and the first two segments on the sides. The third segment is without a ridge on either side parallelling the anterior margin. The lateral carinae of the fourth segment usually end in an acute angle but in some species the distal limits are distinctly rounded but lacking in anterior and posterior angles as in the genus *Lophocyelus;* all the species have a more or less distinct notch in the posterior margin above the angle. Carinae continuous in their descent with the dorsum. Anterior fourth of the dorsum not crossed by a transverse depression as in *Lophocyclus*.

The Hispaniolan species are separated in the following key which has been divided into two sections based on the proportions of the body.

Key to the Hispaniolan species of Cyelodesmus

Body stout, nearly half as broad as long.

Antennae rather long and slender; apical joint of each gonopod long, slender, and without a distinctly evident sheath . . . *obesus* new

Antennae shorter and heavier; apical joint of each gonopod rather short and stout, the sheath distinct . . . . . *erassartus* new

Body more slender, three or four times longer than broad.

Surface of the segments with many short, erect setae giving the body a fuzzy appearance . . . . . *setosus* new

Surface of the segments usually without any erect setae . . . . . .

Segments, except a few at each end of the body, with the posterior margins above the lateral angles distinctly incised, the sinus dentate . . . . . *incisus* new

None of the segments with the posterior margin incised . . . . . .

Body small, not exceeding 6 mm. in length; basal joint of each gonopod produced at the distal end above, into a long, erect conic lobe . . . . . *globulus* new

Body larger, exceeding 6 mm. in length; basal joint of each gonopod simple, not lobed . . . . . .

Gonopods with each apical joint very simple, lacking a definite sheath-like outer piece, the joint straight and held parallel with the body . . . . . *nudatus* new

Gonopods with each apical joint equipped with a distinct outer sheath, the apex of the joint bent outward or toward the body . . . . . .

Gonopods with the sheath-like piece highly developed, separated from the principal or terminal joint and bent toward the body beneath it . . . . . *haitianus* Chamberlin

Gonopods with the sheath-like piece less highly developed and usually adnate throughout its length to the terminal joint.....

Gonopods with the apex of each outer joint bent toward the body but not outward; sternum of the pair of legs following the gonopods narrower than the diameter of a leg socket; angles of segment 2 reaching opposite those of segment 1..... *angustipes* new

Gonopods with the apex of each outer joint bent more or less laterad; sternum of the pair of legs behind the gonopods wider than one of the leg sockets; angles of segment 2 not reaching opposite those of segment 1.....

Gonopods with the projection beyond the sheath of each outer joint quite short and curved slightly toward the body..... *enneryensis* new

Gonopods with the projection beyond the sheath of each outer joint long, produced laterad more strongly than toward the body.

Body not exceeding 8 mm. in length; the sheath of each apical joint of the gonopods with a distinct tooth at the apex on the outer side..... *insulanus* new

Body 10 to 13 mm. long; sheath of each apical joint of the gonopods not toothed at the apex.

Gonopods rather short and stout, the falcate portion beyond each sheath very broadly expanded at the base; sternum of the pair of legs behind the gonopods little wider than a leg socket..... *falcarius* new

Gonopods long and quite slender, the falcate portion slender beyond each sheath; sternum of the pair of legs behind the gonopods nearly twice as wide as a leg socket.

Terminal portion of each gonopod beyond the sheath quite evenly uncinate, the tip simply acuminate..... *montanus* new

Terminal portion of each gonopod bent sharply outward at a right angle beyond the sheath, the tip bifurcate..... *rubellus* new

Cyclodesmus crassartus new species

A single male collected with *C. obesus* at Fond des Negre, April 4, 1930, C. Type in U. S. N. M.

Diagnosis. Most closely resembling *C. obesus* in shape but with the sides of the head notched on each side, the antennae definitely stouter, and the gonopods stouter and with a distinct sheath. The gonopods show some similarity with those of *C. angustipes* but the apical joint

is straighter and a little heavier and the distal end is shorter and does not bend toward the body.

Description. Length 13 mm., width 6 mm. Surface smooth and shining, with fine reticulations and sparse, tiny, and faint longitudinal aciculations.

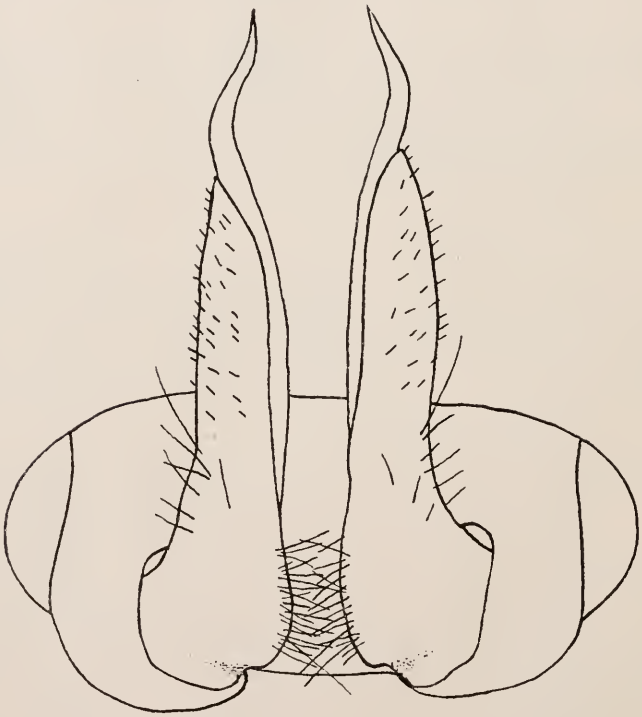


Fig. 34. *Cyclodesmus crassartus.* Gonopods.

Head with the groove of the vertex of uniform depth and width throughout; lateral margin with a deep notch at the middle, with a thin indistinct rim along the margin behind it, but none in front of it. Antennae separated by somewhat more than the diameter of one of the sockets; short and stout as compared to *C. obesus,* joints 2 to 5 inclusive subequal in length, but with joint 6 definitely longer.

First segment emarginate in front, the lateral angles but slightly produced forward, more squarely rounded than in *C. obesus.*

Second segment with each lateral angle narrowly produced to or beyond the angles of the first segment, the raised anterior rim of the angles high and thick.

Third segment with the raised anterior rim broad and high, flattened and broadened at the middle of the dorsum.

Fourth segment with the lateral margin elongate-rounded, the raised rim very broad, including all the surface below the deep notch of the posterior margin.

Ensuing segments conforming to the general pattern of the other species.

Gonopods shorter and stouter than those of *C. obesus*, the apical joint with a distinct outer sheath, finely hairy above and with longer hairs near the base on the outer side; terminal portion short, slenderly acute, extending nearly straight forward (Fig. 34). Genital aperture broadly oval.

Coxae of the 5 pairs of legs in front of the gonopods each with a tuft of long hairs at the apex.

Sternum of the pair of legs following the gonopods narrower than the diameter of a leg socket.

Cyclodesmus obesus new species

One male (type) and 2 females collected at Fond des Negre, April 4, 1930. C. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. This and the correspondingly shaped *C. crassartus* are by far the broadest members of the genus in proportion to their length and in this particular do not appear to be closely related to the other known species. From the form of the gonopods *C. obesus* might be considered as somewhat intermediate in relationship between *C. nudatus* and *C. crassartus*, as shown in the drawings.

Description. Length of the male type 14 mm., width 6 mm.; largest female 16 mm. long and 7 mm. broad. Surface as in *C. crassartus* with the longitudinal aciculations somewhat more numerous and evident.

Head with the groove of the vertex deep, broadening in front above the antennae. Margin of the head on either side in front continuous, rounded, and with a definite raised rim. Antennae separated by considerably more than the diameter of one of the sockets, in shape rather long and slender; joints 2, 3, 5, and 6 subequal in length; joint 4 slightly shorter.

First segment deeply emarginate in front; the lateral angles distinctly produced forward, rounded-acute.

Second segment as in *C. crassartus* but with the raised anterior rim of the produced angles weaker than in that species.

Ensuing segments showing no conspicuous differences from the same segments of *C. crassartus*.

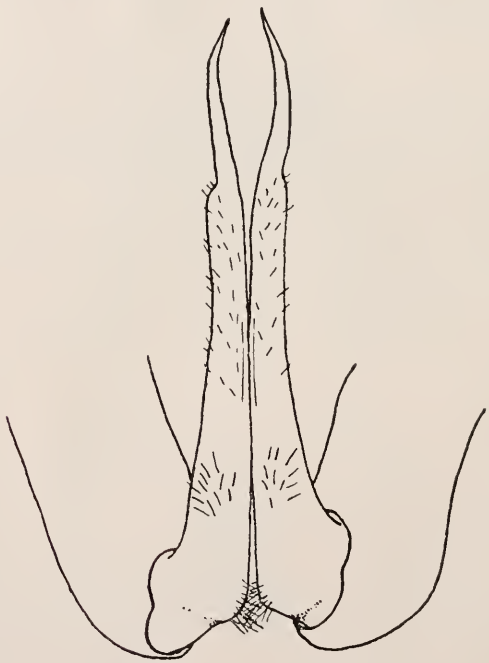


Fig. 35. *Cyclodesmus obesus*. Gonopods.

Gonopods simple and slender, the outer joint of each without a definitely delimited sheath, the rather short, slender, apical portion continuous with the slightly hairy basal portion (Fig. 35). Aperture from which the gonopods arise subrectangular in outline.

Coxae of the 5 pairs of legs just in front of the gonopods with hairs as in *C. crassartus*.

Sternum of the pair of legs following the gonopods narrow as in *C. crassartus*.

Cyclodesmus nudatus new species

One male and two immature females collected at L'Archaie, July 6, 1927, C. & L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Apparently intermediate between *C. angustipes* and *C. obesus* as is shown by the form of the gonopods and the narrow sternum of the pair of legs behind them. The gonopods differ from

Fig. 36. *Cyclodesmus nudatus.* Gonopods.

those of *C. angustipes* in being horizontal and without an apparent outer sheath, and there is a small tuft of very long hairs at the base of each apical joint. In many particulars the gonopods resemble those of *C. obesus,* but the very much more slender body of this species distinguishes it from *C. obesus.*

Description. Length of the type 9 mm. and the width 2.5 mm. Surface smooth and shining, with the usual fine reticulations.

Head with the groove of the vertex long and quite deep. Antennae more widely separated than one of the sockets.

First segment shallowly and broadly but definitely emarginate in front, with the raised rim narrow but quite high; lateral angles rather broadly rounded.

Second segment with the lateral angles not reaching opposite those of the first segment.

Third segment with the raised margin thick and high, the surface immediately behind its limiting furrow depressed in a broad band which is crossed by a few raised lines extending obliquely downward to the furrow.

Fourth segment with each lateral margin rather broadly rounded, subelongate, the posterior margin above it with a tiny but sharp indentation.

Ensuing segments, to near the caudal end of the body, with the anterior surface on each side above the lateral margin depressed for a distance to receive the overlapping posterior margin of the segment in front, when the body is rolled into a ball.

Gonopods very simple, the apical joint horizontal, long, and greatly attenuated, especially the distal third; lacking a distinct outer sheath, although a few tiny hairs near the middle of the joint may indicate that the usual hairy sheath is, in this species, rudimentary and coalesced to the inner portion of the joint; base of each apical joint with a small tuft of very long erect hairs (Fig. 36).

Sternum of the pair of legs behind the gonopods narrower than the transverse diameter of one of the leg sockets.

Cyclodesmus angustipes new species

Two males and many females were collected near Trouin, June 22, 1927, C. & L. Additional specimens from the same locality June 26, 1934, by E. M. and H. F. Loomis. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Seemingly close to *C. haitianus* but with different gonopods. From other species of similar body-form it may be separated by the narrow sternum of the pair of legs following the gonopods, and by the slender simple gonopods, which bend downward toward the body and are protected for over half their length by the outer sheath.

Description. Body of the largest specimen, a female, 12 mm. long

and 3.5 mm. broad; surface smooth and shining but low magnification shows fine reticulations.

Head with groove of the vertex long and quite deep. Antennae separated by more than the diameter of one of the sockets.

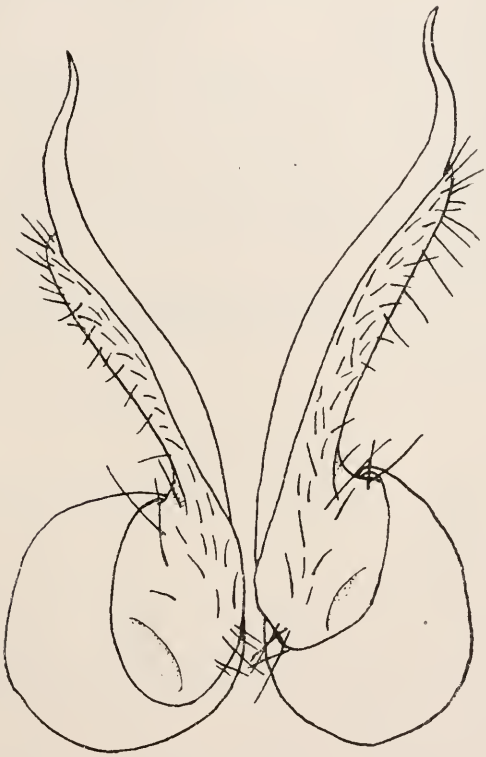


Fig. 37. *Cyclodesmus angustipes.* Gonopods.

First segment very indefinitely emarginate in front, the angles rather broadly rounded.

Second segment with the angles equalling or slightly surpassing those of the first segment.

Third segment with the surface behind the raised margin of uniform height, usually without a broad depressed band paralleling the margin as in *C. euneryensis.*

Fourth segment with the lateral margin somewhat elongate-rounded, not acute, and with a slight indentation in the posterior margin above the angle.

Fifth and sixth segments with the anterior surface above the lateral angles depressed for a considerable distance beneath where the segment in front overlaps, when the body is rolled up; lateral margin of each segment broadly rounded.

Gonopods with the sheath of each erect piece reaching over half way to the apex of the inner portion, which bends gradually toward the body, beyond the sheath, and is very slender; the sheath with scattered hairs from base to apex (Fig. 37).

In the male type the coxa of each fourth leg is produced into a low rounded tubercle at tip, bearing a few long hairs, while in the other male specimen the inner angle of each coxa is prominent but not definitely elevated.

Sternum of the pair of legs immediately following the gonopods especially narrow, not as wide as the transverse diameter of one of the leg sockets.

Cyclodesmus incisus new species

Plate 3, Fig. 1 & 2

Two males and three females collected at Port au Prince, May 19, 1927, L. Six females collected at Diquini, June 27, 1927. L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Differing from other Hispaniolan species in having the posterior margin of the segments incised above the lateral angle, especially on segments 11 to 14, and the margin of the incision dentate. *C. porcellanus* Pocock, from Jamaica, is the only other species with incised posterior margins but the incisions are not dentate and the body is of larger size than *C. incisus*.

Description. Length 6 to 8 mm., width 1.5 to 1.7 mm. Surface smooth and slightly shining and with moderate magnification is seen to be finely reticulated.

Head with the groove on the vertex not especially pronounced. Antennae separated by slightly more than the diameter of one of the sockets.

First segment broadly and shallowly emarginate in front; lateral angles much more broadly rounded than in the other species.

Second segment with the angles quite narrowly produced to opposite the angles of the first segment.

Third segment of the usual shape, the raised margin a little thicker than ordinarily.

Fourth segment with a faint indentation in the posterior margin just above the lateral angle.

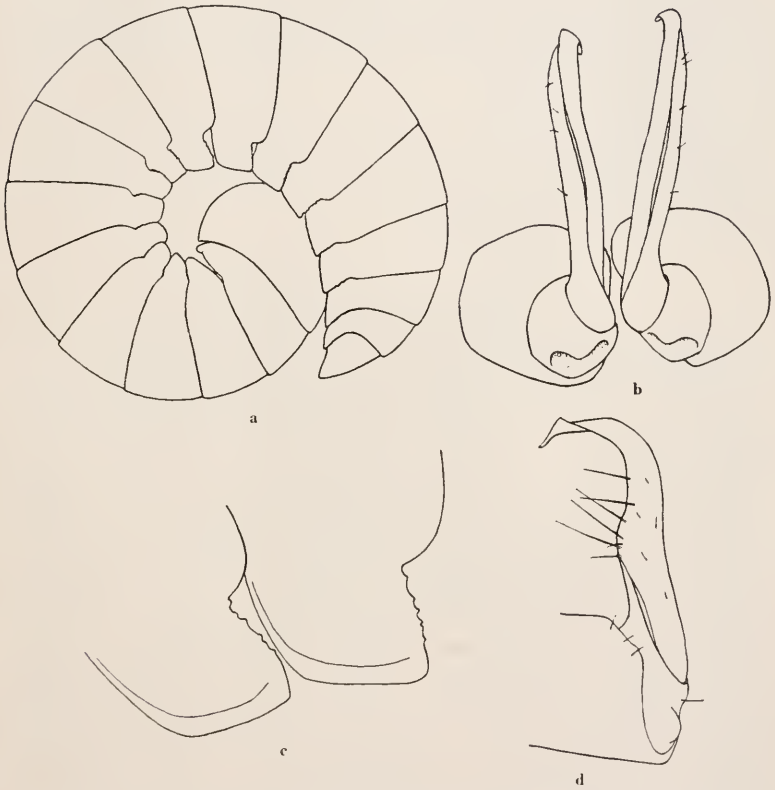


Fig. 38. *Cyclodesmus incisus*. *a*, Partially rolled body with segments in outline, lateral view; *b*, Lateral carinae of segments 12 and 13; *c*, Gonopods; *d*, Gonopod, outer lateral view.

From segment 4 or 5 to about segment 17 the posterior margin is cut away for a considerable distance above the lateral angle on each side, the excisions most extensive and conspicuous from segment 11 to 14, on either side of which they decrease in depth but not in extent,

the margin of the excisions with 3 to 8 small subequal teeth; similar teeth are present on the posterior margin of the antepenultimate and penultimate segments, although no excisions of the margin are evident (Fig. 38, *a* and *b*).

Gonopods long, slender and quite simple, the acute apex bent downward toward the body; outer sheath-like part of the erect portion very slender and indistinctly separated from the inner part, when viewed from above, and when viewed from the side it appears to be distinct from it (Fig. 38, *c* and *d*).

Coxae of the third legs of the males produced forward into rather long cylindrical lobes.

Sternum of the pair of legs behind the gonopods not as wide as the diameter of one of the leg sockets.

Cyclodesmus globulus new species

One male and six females collected between Leogane and Petit Goave, June 28, 1927. C. & L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Not only is this the smallest member of the genus but in no other species is the basal joint of each gonopod produced above into a long conic lobe.

Description. The type, a male, is 5.3 mm. long and 1.2 mm. broad; the largest female is 6 mm. long and 1.5 mm. broad.

Surface smooth and shining but with high magnification is seen to be very finely and faintly reticulated.

Head with a moderately deep groove on the vertex. Antennae separated by about the diameter of one of the sockets.

First segment inconspicuously emarginate in front; lateral angles rather abruptly rounded.

Second segment with the lateral angles reaching almost opposite those of the first segment.

Third and fourth segment of the usual shape, the latter with a very tiny nick in the back margin just above the lateral angle.

Segments with the lateral margin changing from acutely rounded on segment 5 to broadly rounded on segment 9; from segment 10 to the penultimate segment the lateral margin is lengthened and anterior and posterior angles are formed.

Gonopods as shown in figure 39, long and slender, the apex of each greatly attenuated and bending gradually downward toward the body; sheath-like piece showing as a long scale on the outer side of the

apical portion; base of each erect piece with a large conic elevation in front, bearing one or two very long hairs and numerous short ones. Basal joint of each gonopod produced at the distal end above into a long, incurving, horn-shaped lobe reaching a third of the way up the apical piece.

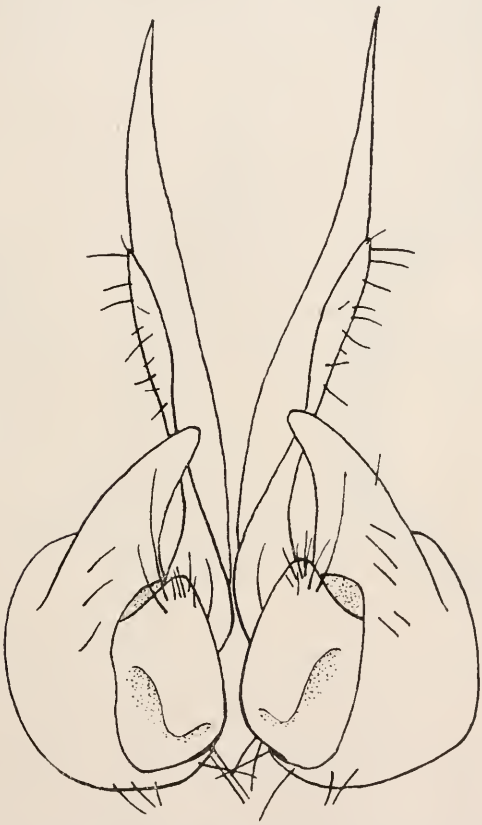


Fig. 39. *Cyclodesmus globulus.* Gonopods.

Males with the coxae of the third legs produced into low rounded knobs directed slightly forward.

Sternum of the pair of legs immediately behind the gonopods as wide as the transverse diameter of one of the leg sockets.

Cyclodesmus enneryensis new species

Two males and 4 females collected at Ennery, July 7, 1927, C. & L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Closely related to *C. montanus* and *C. insulanus* but with the gonopods notably different as shown in the drawings. The sternum of the pair of legs behind the gonopods is nearly twice as wide as one of the leg sockets.

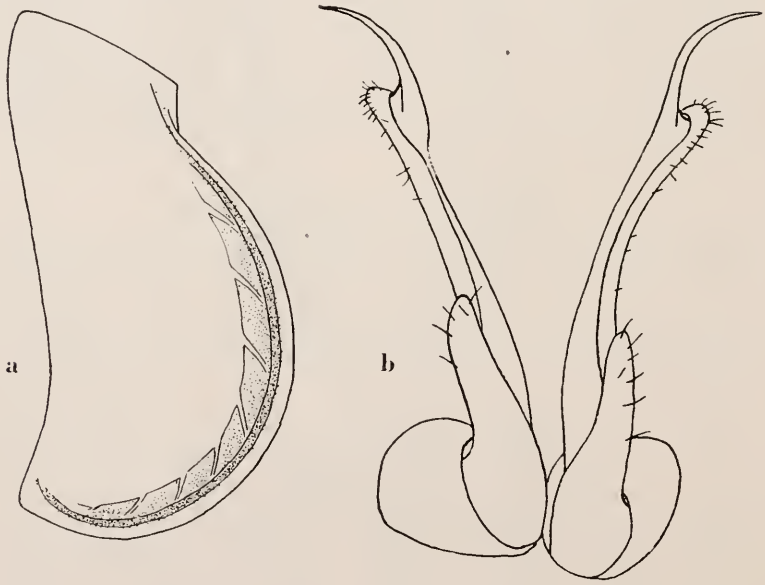


Fig. 40. *Cyclodesmus enneryensis.* *a*, Segment 3, lateral view; *b*, Gonopods.

Description. The largest specimen, a female, is 10 mm. long and 3 mm. broad. Surface smooth and shining with the usual fine reticulations.

Head with the groove on the vertex rather short, but broad and quite deep. Antennae separated by considerably more than the diameter of one of the sockets.

First segment shallowly emarginate in front, the angles moderately broadly rounded.

Second segment with the angles not reaching opposite those of the first segment.

Third segment with the raised margin thick and high, followed by a deep, narrow furrow, behind which is a broad depressed band similar to that in *C. insulanus* but more extensive than that in *C. nudatus*, as it reaches almost to the posterior margin above the angle (Fig. 40, *a*).

Fourth segment with the lateral angle on each side broadly rounded, the posterior margin nicked above the angle.

Ensuing segments to about the seventeenth with the anterior surface, above the lateral angles, depressed to receive the posterior portion of the segment in front, when the body is rolled up.

Gonopods long and very slender, with the sheath of each apical joint reaching almost to the tip of the inner piece and with a distinct shoulder at the apex on the outer side; viewed from directly above, the anterior face of the sheath at base is very prominent, forming what appears to be a long, cylindrical lobe reaching nearly half way up the sheath and with only a very few fine hairs; inner piece of each gonopod with the apex bending downward, toward the body, and outward, and with the tip very fine (Fig. 40, *b*).

Sternum of the pair of legs behind the gonopods nearly twice as wide as the transverse diameter of one of the leg sockets.

Cyclodesmus insulanus new species

A male and a number of females and immature specimens collected on the Ile de Cabrit, near Bayeux, May 12, 1927, L. An immature male collected on the same island July 13, 1927. L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. The very wide sternum of the pair of legs following the gonopods and the sharp tooth at the apex of the sheath-like piece of each gonopod are characters not combined in any other species.

Description. The largest specimen, the male type, is 8 mm. long and 2 mm. broad.

Head with the groove on the vertex not very deep or conspicuous. Antennae separated by more than the diameter of one of the sockets.

Surface of the body smooth and shining as usual.

First segment with the anterior margin almost straight across, very faintly shallowly emarginate when viewed from directly above; raised rim uniform in width throughout, reaching around the corners, which are rather broadly rounded.

Second segment with the angles not reaching opposite those of the first segment by a considerable distance.

Third segment of the usual form, the raised rim rather thick, with a narrow furrow behind it, a broad band just behind the furrow somewhat elevated above it but lower than the rest of the surface, this band crossed with raised lines extending from the higher surface obliquely downward to the furrow.

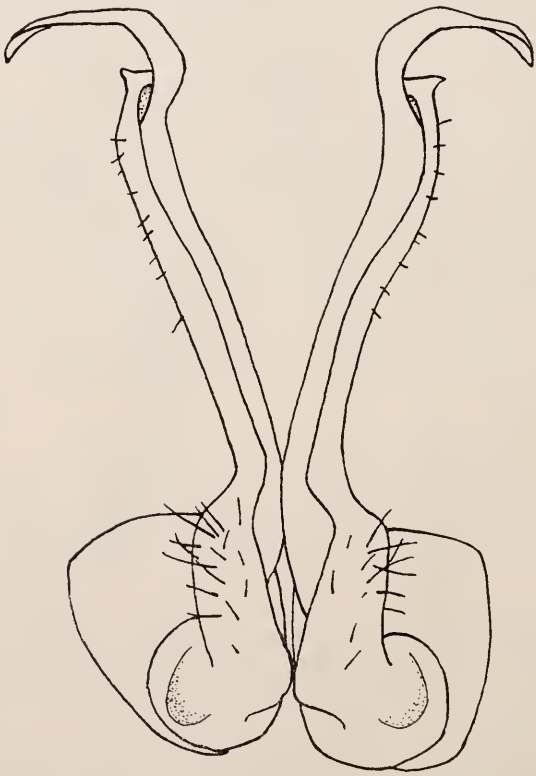


Fig. 41. *Cyclodesmus insulanus.* Gonopods.

Fourth segment with each lateral angle acute; the posterior margin obliquely nicked above the angle to receive the anterior edge of the fifth segment, near the angle, when the body is rolled up.

Fifth segment with the lateral corner on each side rather broadly rounded, the corner of the segment thereafter becoming more obtuse,

and from segment 10 to the penultimate inclusive with anterior and posterior angles formed.

Gonopods long and slender, the inner piece of each gonopod bent sharply outward above the end of the outer sheath-like piece, the apex quite slender; sheath with a small sharp tooth at the apex on the outer side, the base of the sheath enlarged but not developed into a lobe or tubercle, the surface with rather long scattered hairs (Fig. 41).

Coxae of the third and fourth male legs normal.

Sternum of the pair of legs immediately behind the gonopods equal to at least twice the transverse diameter of one of the leg sockets.

Cyclodesmus montanus new species

Two males and several females collected on Morne Pilboreau, above Ennery, May 24, 1927. L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. The position of this species seems to be intermediate between *C. insulanus* and *C. rubellus*. It differs from *C. insulanus* in lacking a tooth at the apex of each sheath of the gonopods, and is readily distinguished from *C. rubellus* by having the apex of each gonopod forming an almost uniformly curved, acute tipped hook; the outer sheath is much better developed than in *C. rubellus*.

Description. The largest specimen, a female, measures 13 mm. long and 3 mm. broad. Surface of the body smooth and shining.

Head with the groove of the vertex long and not especially deep. Antennae not separated by a distance greater than the diameter of one of the sockets.

First segment shallowly emarginate in front, the angles rather acutely rounded.

Second segment with the angles remote from those of the first segment.

Third segment not noticeably different from that of *C. enneryensis*.

Fourth segment with each lateral corner acute; posterior margin above the angle with a deep and oblique notch to receive the edge of the fifth segment, when the body is rolled up.

Lateral margins increasingly more broadly rounded from segment 5 to segment 8 inclusive, segment 9 with anterior and posterior lateral corners slightly angled but becoming more so on the ensuing segments. From segment 5 to the middle or posterior quarter of the body the segments have the anterior surface depressed for a distance above the

lateral margin to accommodate the overlapping segment in front, when the animal rolls itself into a ball.

Gonopods long and slender, the sheath of each outer joint distinct, and with the slender, falcate tip of the inner piece proceeding from its

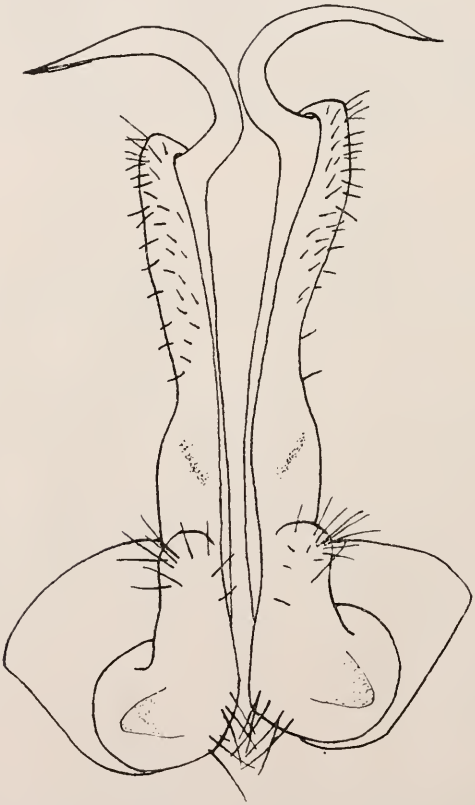


Fig. 42. *Cyclodesmus montanus* Gonopods.

inner side, just below the apex, and curving forward and outward; base of the sheath rather prominently elevated for a short distance, the distal end of the elevation with a few long hairs (Fig. 42).

Sternum of the pair of legs behind the gonopods nearly twice as wide as the transverse diameter of one of the leg sockets.

CYCLODESMUS RUBELLUS new species

Numerous males (one the type) and females collected at Le Borgne, on the north coast, March 26, 1930. C. Type in U. S. N. M. Paratype in M. C. Z.

Fig. 43. *Cyclodesmus rubellus.* Gonopods.

Diagnosis. This species is at the extreme end of the series having the apical portion of the terminal joint of each gonopod slender and held at a right angle to the basal portion. Its closest relatives are *C. insulanus* and *C. montanus* but the apical portion of each gonopod is much more slenderly produced and ends in a distinct fork of two fine, equal prongs.

Description. Length of the largest specimen, a female, 13 mm., width 3.5 mm. Surface smooth and shining, the reticulations faint, requiring moderately high magnification to be seen.

Color pink in life, slightly so in alcoholic specimens.

Head with the groove of the vertex deep, crossed by numerous fine, short, transverse impressions. Antennae long, slender, separated by slightly more than the diameter of a socket; joints 3 and 6 subequal, longer than joints 2, 4 or 5, which are of equal length.

First segment broadly emarginate in front; the raised margin strongly developed; lateral angles rather sharply rounded.

Second segment with the lateral angles not quite reaching the angles of the first segment.

Third segment with the raised anterior margin thick and high, the surface immediately behind its posterior limiting furrow depressed and crossed obliquely downward from behind by a few raised lines as shown in the drawing of *C. enneryensis.*

Fourth segment terminating on each side in a rather sharp angle which is caused to appear produced backward by the indentation in the posterior margin just above it.

Ensuing segments with the anterior lateral surface on each side depressed in the usual way to receive the posterior portion of the segment in front, when the body is rolled for protection.

Each gonopod with the basal joint long, smooth, and cylindric; the terminal joint slender, bowed toward the body, sheath closely applied and with a few very short hairs; apical portion of the joint directed laterad, forming a right angle with the supporting portion, in shape very long and slender, the outer half curving toward the body and the apex divided into two fine, subequal prongs (Fig. 43).

Sternum of the pair of legs following the gonopods considerably broader than the diameter of the leg socket on either side.

Cyclodesmus falcarius new species

Several male (one the type) and female specimens collected on Morne Pilboreau, above Ennery, April 5, 1926, C.; July 8, 1927. C. & L. Type in U. S. N. M. Paratype in M. C. Z.

This species is of the same size and form as *C. montanus,* collected in the same locality, but the following differences exist.

Head with the groove of the vertex long but quite faint. Antennae separated by slightly less than the diameter of one of the sockets.

Segment 4 with each lateral angle scarcely as acute as in *C. mon-*

tanus and with the posterior margin much less deeply and obliquely notched above the angle.

Gonopods shorter and stouter than those of *C. montanus*, the sheath of each outer joint not terminating in a distinct shoulder, separate

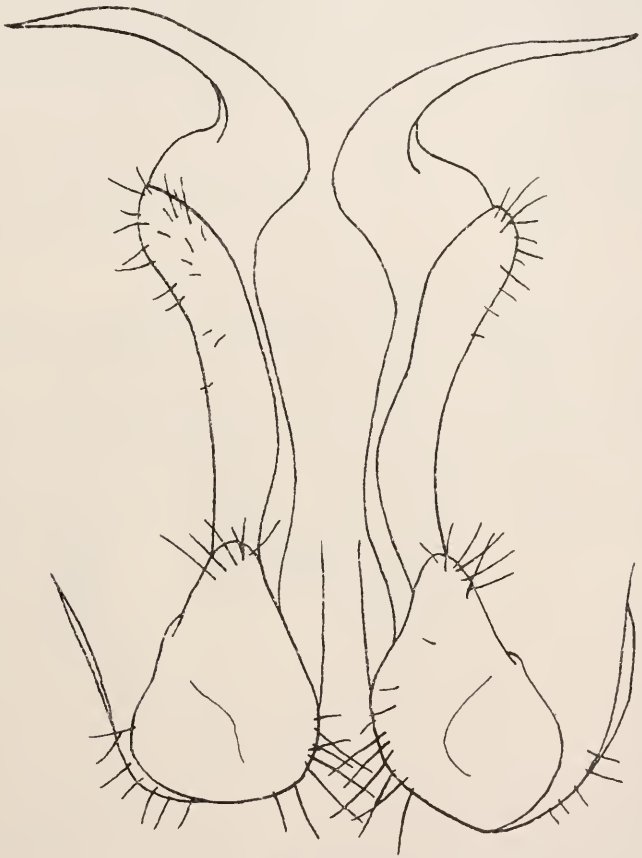


Fig. 44. *Cyclodesmus falcarius*. Gonopods.

from the inner piece, but continuous with it; inner piece with the falcate extension beyond the sheath very broadly expanded at base, above which it curves abruptly outward to an acuminate ending (Fig. 44).

Sternum of the pair of legs behind the gonopods but little wider than the transverse diameter of one of the leg sockets.

Cyclodesmus haitianus Chamberlin

Cyclodesmus haitianus Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 215, 1918.

Chamberlin listed Diquini and Petionville as localities for this species but no specimens were found by the writer in either place and, as the species was based on females, its identity remained in doubt until June 23, 1934 when the writer collected, at Kenscoff, specimens of

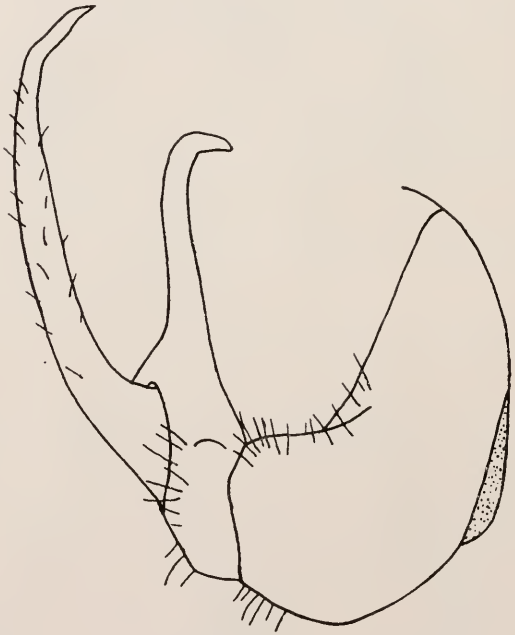


Fig. 45. *Cyclodesmus haitianus*. Gonopod, oblique outer view.

both sexes which appeared to represent this species. The following notes were made from these specimens.

The largest specimen is a female 16 mm. long and 5 mm. wide.

First segment with the anterior margin straight across.

Second segment with lateral angles not reaching opposite those of the first segment.

Third segment with a submarginal depressed area such as found in *C. enneryensis*.

Fourth segment with the lateral margin acute; posterior margin notched above the angle.

Most of the specimens show a very few scattered erect setae close to the back margin of the posterior segments, and on the other segments single setae here and there indicate that in perfectly preserved specimens all segments would have a few setae, but by no means the numbers as on *C. setosus*.

Gonopods with the usual sheath-like portion more highly developed than in the other species and distinctly separated from the principal joint and held beneath it, with the apex curved outward (Fig. 45).

The males have the last joint of all legs, to near the back end of the body, densely pubescent beneath, in conspicuous contrast to the rather sparse pubescence on the female legs.

Cyclodesmus setosus new species

One female collected between 6000 and 7000 feet elevation at La Vestite, Sept. 16 to 23, 1934 by P. J. Darlington. Type in M. C. Z.

Diagnosis. The numerous dorsal setae make this species instantaneously recognizable but the shape of segment 1 also is distinctive.

Description. Length 16 mm. width 4 mm. the body rather narrow for its length; lateral carinae continuous with the sides, descending vertically. Color white. Surface beset with erect setae giving the body a fuzzy aspect, the setae rising from conspicuous dark follicles, possibly darkened by the alcoholic preservative.

Head sparsely hairy below the antennae; a few hairs directly above each of the sockets; groove of the vertex deep.

First segment almost semi-circular, the anterior margin straight across, the lateral margins curved and almost continuous with the posterior margin; segment slightly over twice as wide as long; lateral angles rather obtuse; surface scattered with a few stiff, erect hairs or setae.

Second segment with the produced angles considerably exceeding the angles of the first segment. Anterior margin and both margins of the produced carinae raised. Surface with over 40 stiff erect hairs scattered over the posterior portion of the dorsum and carinae. On succeeding segments the hairs increase materially in numbers, are confined to the posterior half of the segments, and are decidedly more abundant at the posterior margin.

Third segment with the lateral carinae not expanded forward as much as in most of the other species of the genus, more closely resemb-

ling the carinae in the genus *Lophocyclus* but without the characteristic lateral ridge.

Fourth segment with the outer margin of the carinae slightly lengthened but not as much as in *Lophocyclus*.

Ensuing segments similar to those in the other species except for the numerous dorsal setae.

Last segment glabrous except for four setae across the middle, and four others immediately in front of the posterior margin.

Inasmuch as no male has been seen the exact generic location of this species cannot be determined, but it has more characters in common with *Cyclodesmus* than with *Lophocyclus* and so has been placed in the former genus. The numerous dorsal setae at first were thought sufficient grounds for designating this species as the type of a new genus, but later the discovery of a few setae on the dorsum of *C. haitianus* indicated that not all the species of *Cyclodesmus* were glabrous, and the present species is considered as representing an extreme departure from the general mass of species in that genus, but one not lacking a connecting link with them.

Lophocyclus new genus

Type *Lophocyclus laxatus* new species.

Diagnosis. The strong ridge on each side of segment 3; the truncated lateral carinae of segment 4; and the incrusted surface of the segments are the outstanding points for recognition of this genus.

Description. Body of the same proportions as *Cyclodesmus* and capable of being rolled into a ball. Surface more or less coated with an incrustation of foreign organic matter. All segments with a few erect setae on the dorsal surface.

Head with a deep groove on the vertex. Surface below the antennae beset with erect setae.

First and second segment of the same general shape as in *Cyclodesmus*.

Segment 3 much less produced forward on the sides in front than in *Cyclodesmus*. Raised rim of the anterior margin very narrow and with a broad, deep channel behind it which is in turn followed by a prominent ridge extending from each lateral angle to near the middle of the dorsum where it is broadest and verges with the dorsal surface (Fig. 48).

Carinae of segment 4 with a long lateral margin and distinctly

angled anterior and posterior corners. Posterior margin not notched above the angle.

Segments 5 to 9 inclusive resembling those of *Cyclodesmus* but with the carinae more slender and terminating in sharper angles, apparently to compensate for the lengthening of the lateral margin of the carinae of segment 4, and to allow the body to be rolled into a compact ball; the lateral margins of the carinae behind segment 9 are shorter than in *Cyclodesmus*, and this also probably is a compensating factor towards forming a protective ball.

Gonopods having considerable resemblance to those of *Cyclodesmus*.

Key to the Species of Lophocyclus

Length over 20 mm.; lateral carinae noticeably spread outward from the line of descent of the sides of the dorsum ..... *passus* new

Length 16 mm. or less; lateral carinae little or not at all spread away from the line of descent of the sides of the dorsum .....

Lateral carinae thickened, especially those just behind the middle of the body; segments with a series of setae very close to the posterior margin ..... *laxatus* new

Lateral carinae thin on all segments; dorsal setae considerably removed from the posterior margin and none in definite series .....

Length near 16 mm.; second segment enclosed on all sides by the raised margin; posterior half of segments not conspicuously convex ..... *munitus* new

Length about 9 mm.; second segment with posterior margin not raised along the median portion; posterior half of segments strongly convex ..... *pumilus* new

LOPHOCYCLUS PASSUS new species

A single male collected at Roche Croix, 5000 feet elevation, Oct. 13, 1934 by P. J. Darlington. Type in M. C. Z.

Description. This is the largest member of the family thus far described, the length being 22 mm., width 8 mm. Body slightly dirt-encrusted, the deposit being heaviest on the lateral carinae and the anterior portion of each segment in the broad shallow constriction which is nearly covered by the segment in front when the body is unrolled.

Head with a deep furrow on the vertex; front and sides below the antennae with many erect hairs of varying length.

First segment quadrilateral with the side margins strongly converging from front to back; surface with 10 erect setae in a series along the back and side margins; in addition there is a single seta on either side of the middle of the disc at the anterior fourth.

Second segment with the lateral angles reaching opposite those of the first segment. All margins except the median posterior margin narrowly raised. Surface with a broad, shallow transverse depression

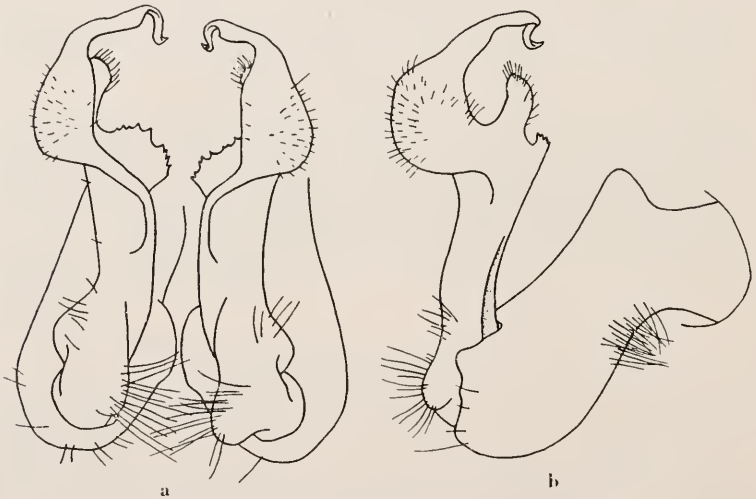


Fig. 46. *Lophocyclus passus*. *a*, Gonopods; *b*, Outer lateral view of a gonopod.

immediately behind the anterior median margin; a series of 16 to 18 erect hairs extend across the posterior portion of the segment and onto the lateral carinae nearly to their extremities, the setae rising directly from the smooth surface.

Segment 3 with the anterior lateral margins slightly raised, the surface ridge behind the margin broad and low; dorsal median surface and the surface behind the ridge with a few scattered erect setae; posterior margin of this and succeeding segments to the antepenultimate without setae.

Segment 4 with lateral margin of the carinae of moderate length, slightly rounded and with angles also somewhat rounded.

Dorsum strongly convex, the sides evenly descending to the lateral carinae which change the angle of descent and flare slightly outward.

Lateral carinae thin as in two of the other species, the outer margin lacking setae.

Gonopods as shown in figure 46, *a* and *b*.

Lophocyclus munitus new species

Two males and one female collected at 5000 feet elevation at Roche Croix, Oct. 13, 1934 by P. J. Darlington. Type and Paratypes in M. C. Z.

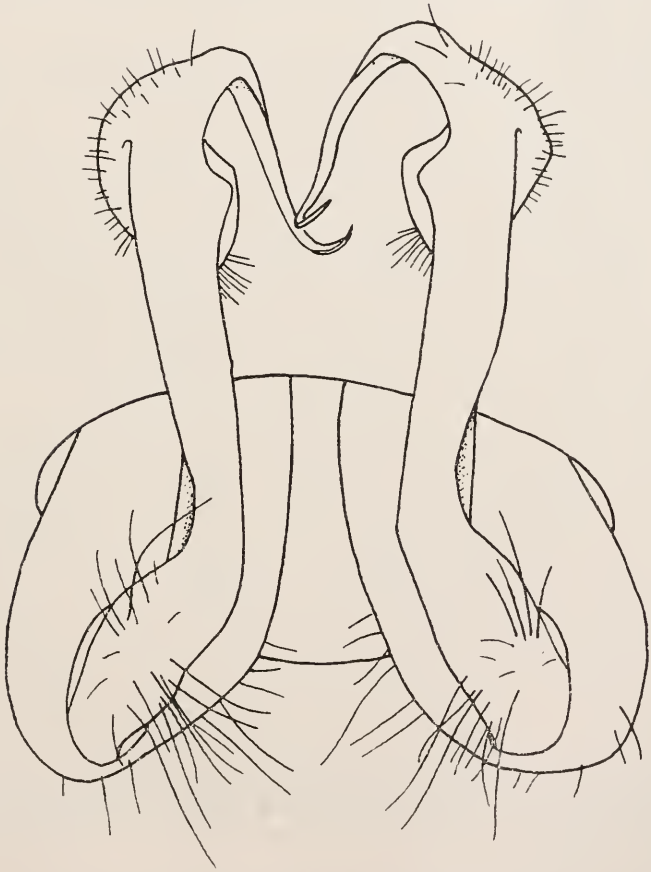


Fig. 47. *Lophocyclus munitus*. Gonopods.

Diagnosis. Closely related to *L. laxatus* which it resembles in size and superficial appearance but distinguished by the lack of a series

of setae along the posterior margin of the segments, by the broader lateral carinae of segments 5 to 8, and by the thinner carinae.

Description. Length 16 mm., width 4 mm. Body moderately incrusted with an organic accumulation heavier than in *L. passus* but less than in the other two species; the accumulation thickest on the lateral carinae, the dorsum quite clean and shining. Dorsum strongly convex, the sides descending almost vertically, the carinae making an almost continuous descent from the dorsum, not flaring away from it as in *L. passus*.

Head and first segment much as in *L. laxatus* but segment 2 with all margins raised, the posterior margin less than the others. Just in front of the posterior margin the surface is raised into a broad, low ridge; anterior surface slightly depressed transversely.

Segment 3 has the anterior rim and the surface ridge behind it thinner and higher than in the other species, the intervening channel correspondingly deeper. Behind the ridge there are a few long, slender setae rising from tiny tubercles indefinitely arranged. Ensuing segments have similar setae sparsely scattered over the surface but not along the posterior margin except on the last segment where several setae are present in one specimen but are rubbed off from the others.

Segment 4 with the outer margin of the carinae slightly more rounded and the angles not quite so acute as in *L. laxatus*.

Segments 5 to 8 with the lateral carinae slightly broader than in *L. laxatus;* all carinae thinner than in that species, and those near the middle of the body without the definite prominence on the ventral surface adjacent to the anterior corner. Dorsal surface along the posterior margin of the mid-body segments very faintly raised into a low ridge. Anterior transverse constriction broad and shallow beneath the preceding segment, scarcely noticeable.

Gonopods shown in figure 47, resembling those of *L. passus* to some extent but with obvious differences.

Lophiocyclus laxatus new species

The type, a female, collected north of Trouin, June 26, 1934 by E. M. and H. F. Loomis. Two paratype females were collected between Jacmel and Trouin on May 21, 1925 and April 11, 1926, by O. F. Cook. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Distinguished from *L. munitus* by the presence of a series of setae along the posterior margin of the segments and one or two setae in the outer margin of the lateral carinae beginning with

segment 6. The lateral carinae are slightly more slender and definitely thicker than in the other species.

Description. Maximum length 16 mm., width 4 mm. Color white beneath the rather dark brown incrustation which covers the nearly smooth surface.

Head with groove of the vertex deep; frontal region bearing erect setae to well above the base of the antennae.

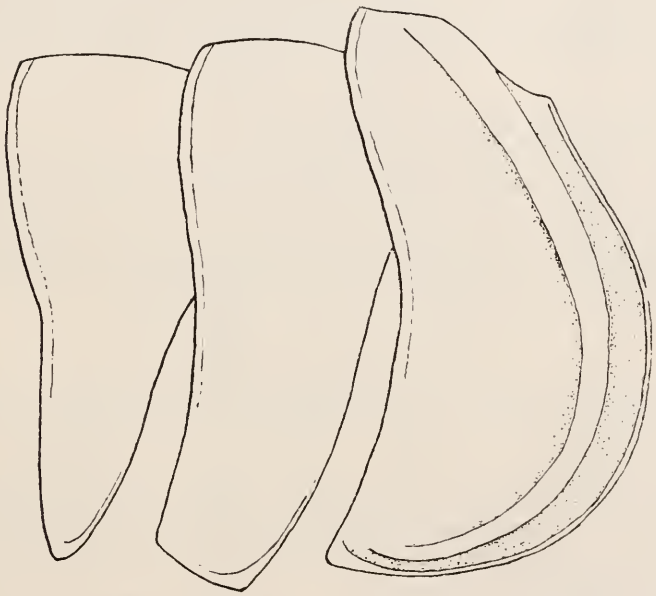


Fig. 48. *Lophocyclus laxatus.* Segments 3, 4 and 5, lateral view.

First segment somewhat emarginate in front, the raised rim thin and high. Setae on the surface of segment 1 and 2 as in *L. munitus* but from segment 3 to the posterior end of the body short setae form a series close to the posterior margin of the segments with a few setae scattered in front of them; segments 6 to 8 with a single seta projecting outward from the extremity of the lateral carinae; from segment 9 backward there are two setae in the elongated outer margin of the carinae.

Segment 2 with the produced angles not reaching those of the first segment by a considerable distance; all margins raised except the median posterior margin.

Segment 3 with the surface ridge on each side strongly developed, broader but not quite as high as that in *L. munitus*. Surface just in advance of the posterior margin of this and succeeding segments slightly elevated into a slight, inconspicuous ridge. (Fig. 48).

Segment 4 with the outer margin of the carinae long and straight, the anterior and posterior corners forming right angles.

Segments 5 to 8 have the lateral carinae quite noticeably slenderer, and the carinae of all segments behind segment 3 or 4 thicker than in the other species; the carinae just behind the middle of the body have a small raised prominence on the ventral side near the anterior corner.

No males of this species have been seen.

A very tightly rolled dead specimen, apparently somewhat longer than *L. munitus* or the foregoing species, and 5 mm. wide, was found by the writer on Morne Pilboreau, July 8, 1927. The specimen was in such poor condition that its true characters could not be determined but it would be surprising indeed if future specimens showed it to be one of the species inhabiting the southern peninsula.

Lophocyclus pumilus new species

One broken male collected between 3000 and 7800 feet elevation on Morne La Hotte, Oct. 16–17, 1934 by P. J. Darlington. Type in M. C. Z.

Diagnosis. The smaller size; general incrustation of organic matter; more distinct transverse constriction on the forward part of the dorsum of each segment; and the greater convexity of the posterior part of the segments, are characters which, in addition to the gonopods, distinguish this species.

Description. Length about 9 mm. width 3 mm. Dorsum and sides heavily coated with a dark brown incrustation of organic matter apparently, only the ridge on either side of the third segment being rubbed clean. Dorsum strongly convex, the carinae not descending continuously with the sides but flaring slightly away from them.

Head with a deep median groove on the vertex.

First segment evenly convex, it and the next segment with setae much as in *L. passus*, but as the setae are not borne on tubercles, and some setae are missing, the number and arrangement are impossible to determine.

Second segment with the posterior portion of the surface strongly convex but not raised into a definite ridge; posterior margin flat but the other margins finely raised.

Third segment with the ridge on either side narrow but high, particularly near its upper limits. Behind these ridges is a row of at least 10 erect setae and other setae may have been included but

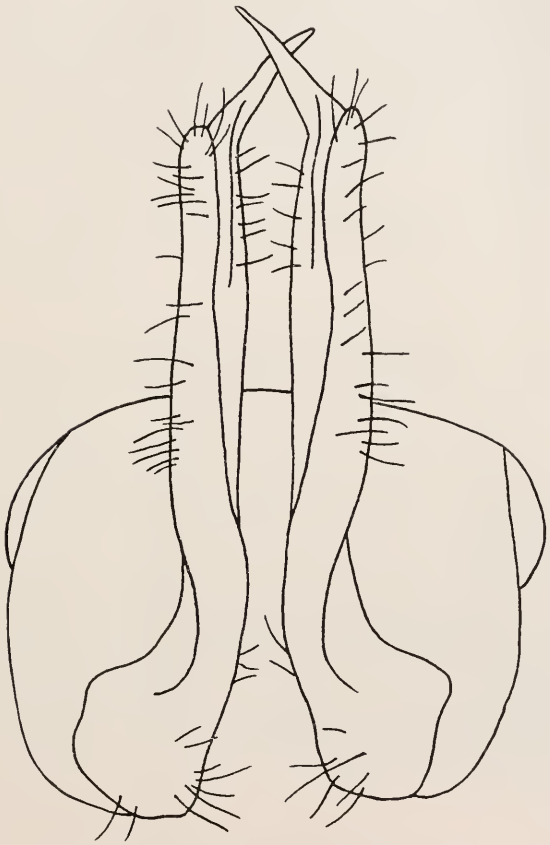


Fig. 49. *Lophocyclus pumilus*. Gonopods.

if so they now are missing. Posterior surface along the margin raised into a slight ridge, especially on the sides.

Fourth segment with the outer margin of the carinae long and nearly straight, the corners angular-rounded, the raised rim of the margin heavy.

Succeeding segments with the surface incrustation seemingly thicker on the posterior half of the segments than on the anterior portion but removal of the incrustation shows the anterior fourth to be crossed by a transverse depression which is more pronounced than similar depressions in the other species; behind this depression the surface is strongly convex and on the posterior segments this surface, with its accumulation of matter, appears almost as a ridge. On the back half of these segments a few short, scattered hairs project through the incrustation but none are in a series close to the margin as in *L. laxatus*.

Gonopods as shown in figure 49, simpler than in the other species of which males are known.

Family STRONGYLOSOMIDAE

Orthomorpha Bollman

Orthomorpha coarctata (Saussure)

Polydesmus coarctata Saussure, Mem. Myr. Mex., p. 297, 1860.
Strongylosoma poeyi Bollman, Ent. Amer., p. 82, 1887.
Strongylosoma coarctatum Pocock, Jour. Linn. Soc., **24**, p. 512, 1894.
Orthomorpha coarctata (Sauss.) Bollman, U. S. Nat. Mus., Bul. 46, p. 196, 1893.

This is a cosmopolitan species of wide distribution in the Tropics. It is common throughout Haiti, having been found in the following localities. Port au Prince, Momance, Cape Haitien, Grande Riviere, Ennery, Manneville, Jacmel, Petionville, Diquini, Bayeux, Artibonite River between St. Marc and Gonaives; Trouin; "Etang La Chaux" (P. J. Darlington).

Family CHELODESMIDAE

Key to the Hispaniolan genera of Chelodesmidae

Repugnatorial pores opening from a callus set off from the rest of the margin.

Body composed of head and 19 segments. . . . *Ellipodesmus* Chamberlin
Body composed of head and 20 segments. . . . . .

Carinae of segments 2 to 4 without a marginal tooth.....
Achromoporus new
Carinae of segments 2 to 4, at least, with a tooth at the anterior corner.
Gonopods with the end of each posterior division developed into a long, slender, more or less coiled style; each anterior division also somewhat coiled and usually crossing the opposite division.....*Amphelictogon* Chamberlin
Gonopods with posterior divisions not developed into coiled styles at tip nor are the anterior divisions coiled or crossing each other.
Posterior margin of segments without projecting teeth.....
Chondrotropis new
Posterior margin of segments with distinct teeth.....
Poriferous segments differing in color pattern from the segments without pores.....*Beatadesmus* Loomis
Poriferous and non-poriferous segments similar in color.....
Quisquicia new
Repugnatorial pores opening from a simple thickening of the margin
Lateral carinae reduced in size, scarcely projecting from the sides of the body.....*Pterygiodesmus* new.
Lateral carinae or normal size, strongly projecting from the sides of the body.....
Pores opening from the dorsal surface of the lateral carinae.....
Aplopododesmus new
Pores opening outward from the margin of the lateral carinae.....
Color pattern of poriferous and non-poriferous segments similar; segments with three transverse rows of setae on the dorsum; males without modifications of the legs and sterna in front of the gonopods.....*Pogonodesmus* new
Color pattern of poriferous segments different from that of the non-poriferous segments; dorsum of segments without transverse rows of setae; pregenital male legs or sterna with secondary sexual modifications.....*Cyrtaphe* new

Ellipodesmus Chamberlin

Ellipodesmus simplex Chamberlin

Ellipodesmus simplex Chamb., Bull. Mus. Comp. Zool., **62**, No. 5, p. 243, 1918.

Jacmel (type locality).

No specimens of this species have been examined.

Achromoporus, new genus

Type. *Achromoporus coloratus* new species.

Body with 20 segments; females usually distinctly stouter and more convex than the males, the latter usually with the sides slightly converging caudad behind the third segment. Surface of all segments smooth and shining, the posterior subsegments not transversely furrowed, none of the margins toothed. Color, when present, usually confined to the nonporiferous segments.

Head with a long, deep groove on the vertex. Antennae with joints 2 to 6 inclusive of nearly uniform length. Antennae of the males inconspicuously stouter than those of the females.

First segment semielleptic, the posterior margin broadly and quite deeply emarginate at middle.

Pores borne on the customary segments, the poriferous swelling large, conspicuous, and on the anterior segments more vertically depressed and with the pore opening from nearer the dorsal surface than on the posterior segments.

Last segment produced into a downward curved, truncate mucro.

Anal valves with greatly raised and thickened margins, the disc of each valve strongly convex. A seta is borne on each margin near the upper fourth and another is located on each disc opposite the lower third of the margin.

Preanal scale triangular, the apex sometimes produced backward.

Legs with the third joint longer than any of the others and in the males with a low swelling on the ventral surface of legs 3 to 7, near the basal fourth; several of the legs following the gonopods with decreasing swellings in the same position.

Coxae of the second legs of both sexes with the inner corner more or less elevated into a conic tubercle which is usually larger in the males.

Sternum of the third legs of both sexes with a conic tubercle on each side of the median depression in three of the species but in the type species these tubercles are reduced to very slight swellings.

Gonopods with the anterior division erect, terminating in a short, incurving hook; posterior division slightly exceeding the anterior division, bifurcate, the two arms thin and only slightly curving inward or backward, subequal in length, the posterior sometimes considerably broader and more blade-like than the anterior; base of the joint densely hairy at its inner corner.

The four species of this genus are separated in the following key.

Key to the Species of Achromoporus

Vertex of head, outer antennal joints, and the ventral surfaces, except the sterna and the under side of the keels, brown in addition to the dorsal markings; sternum of the third legs of both sexes lacking two conic tubercles ..... *coloratus* new

Head and the antennae light, ventral surfaces partly or entirely light colored, the dorsum usually with some brown markings; sternum of the third legs of both sexes with a distinct conic tubercle on each side of the impressed median line .....

Males stout and strongly convex and with the sides of the body parallel, except at the extremities; preanal scale with the apex definitely prolonged into a slender tip; specimens entirely white ..... *robustus* new

Males more slender and somewhat flattened, the sides of the body slightly converging caudad beginning with the fourth segment; preanal scale not definitely prolonged at the apex; most specimens with some brown on the dorsum .....

Preanal scale triangular, the sides straight and continuous from the lateral angles to the apex; anterior division of the gonopods with the inner side descending in a nearly vertical line from the apical hook; posterior division of the gonopods with the posterior blade very broad and with a broadly rounded apex *enneryensis* new

Preanal scale with a slight emargination on each side near the apex; anterior division of the gonopods with the inner side produced abruptly mesad below the apical hook; posterior division of the gonopods with both blades slender and acute at tip ..... *furcipes* new

ACHROMOPORUS COLORATUS new species

Many males (1 the type) and females collected at Thor, near Port-au-Prince, May 19, 1927, L. Other males and females from Diquini, June 26, 1927 and Carrefour, July 3, 1927, C. & L. One male between Petionville and Kenscoff, June 23, 1934, L. Type in U. S. N. M. Paratype in M. C. Z.

Length from 20 to 26 mm. Males more slender, much flatter and with the lateral carinae projecting further from the sides of the body than in the females; males definitely narrowing caudad behind the third segment, the females with sides parallel except at the extremities.

Living color mostly white, a dark internal median line showing through the segments from the second to the penultimate inclusive.

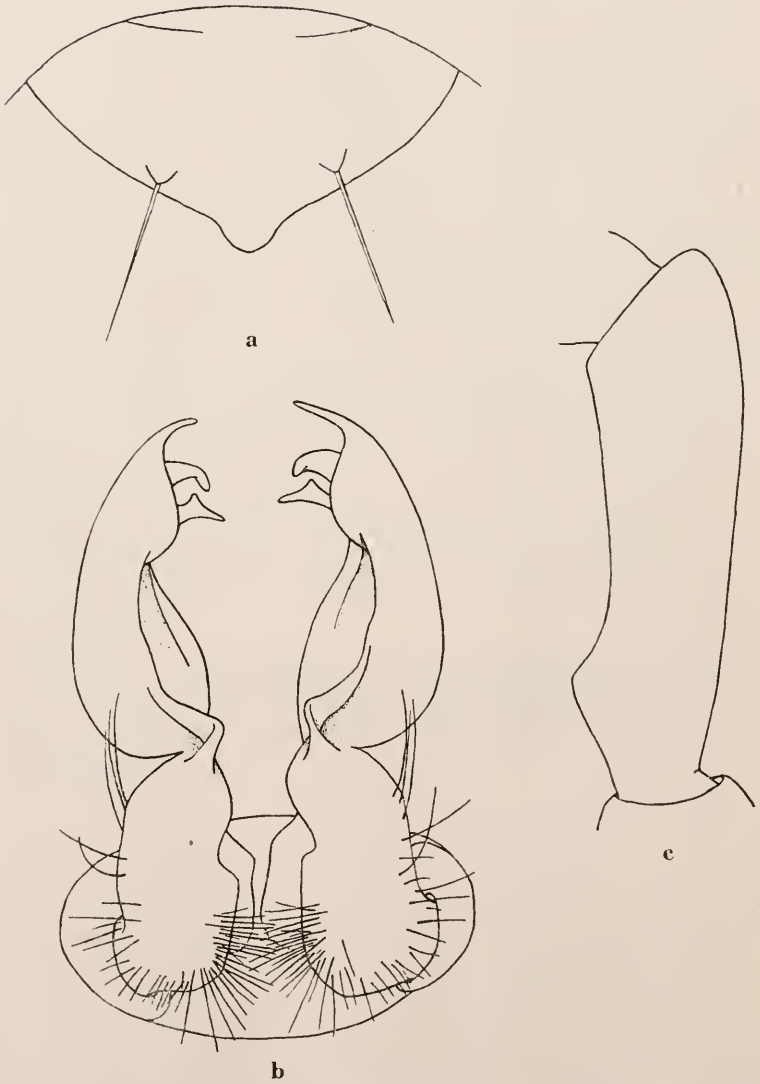


Fig. 50. *Achromoporus coloratus*. *a*, Preanal scale; *b*, Gonopods; *c*, Third joint of sixth male leg.

Head dark brown, to a little below the antennae, the clypeal and labral region white. Basal joint of the antennae light colored, the

other joints brown. First segment with the margins and a longitudinal median line solid white, a large area on each side of the middle maculate with white on a semitransparent ground; in fully marked specimens there is a dark brown spot on each side close to the front margin and nearer the lateral angle than the middle of the dorsum. Segments 2, 3, 4, 6, 8, 11, and 14 white with a large dark brown spot on each side, half of which is on the keel and dorsum of the posterior subsegment and the other half on the anterior subegment. Last segment with a large dark brown spot on each side in front. Poriferous segments white, with a semitransparent spot, maculate with white, on each side in a position similar to the brown spot of the other segments, although in some well-marked females a small brown spot is present in each of these areas. Ventral surfaces mostly dark brown, the sterna, under side of the keels, and the legs light colored.

Preanal scale rounded-triangular, with the apex somewhat produced, the margin on each side of it being slightly rounded, (Fig. 50, *a*).

Second legs of both sexes with the inner corner of each coxal joint produced into a short conic tubercle.

Sternum between the third legs of both sexes depressed at middle but with only a slight swelling on each side of it.

Gonopods as shown in figure 50, *b*, the anterior division on each side is explanate at the apex, almost bifureate; the posterior division with the tip of the posterior arm distinctly attenuated, the mesial margin just below it expanded inward.

Anterior legs of the males with the prominence on the ventral side of the third joint conspicuous (fig. 50, *c*); present on several of the legs behind the gonopods but decreasing in size.

Achromoporus ennerensis new species

Two males (1 the type) collected at Ennery, July 6, 1927. C. & L. Four males collected on Morne Pilboreau, above Ennery, July 8, 1927, C. & L. Type in U. S. N. M. Paratype in M. C. Z.

Length 18 to 24 mm. Males more convex and less attenuated behind than in *A. coloratus*.

The living color of this species is brown and white arranged as in *A. coloratus* but the brown is lighter and the spots are smaller. In all specimens the head, antennae, first segment, legs, and sterna are light colored; the sides of the body below the keels showing light brown in the most fully colored specimens; one of the specimens has no brown color above or below.

Preanal scale with the tip very indistinctly prolonged, the margin on each side of it very faintly emarginate.

Second legs with the inner corner of each coxal joint only slightly produced, forming a low rounded tubercle.

Sternum between the third legs with a conspicuous conic tubercle on each side of the impressed median furrow.

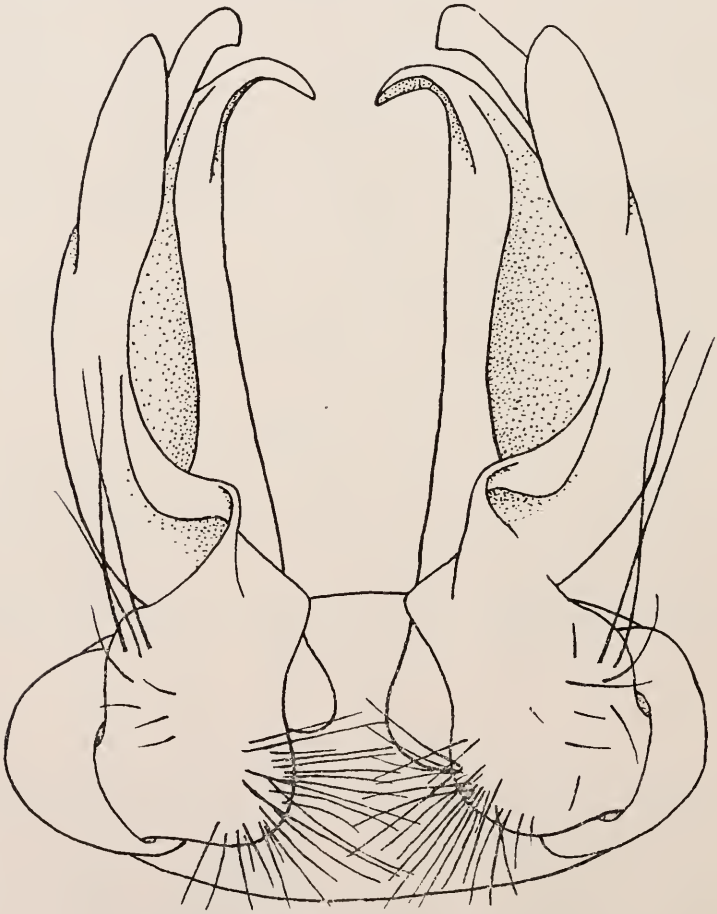


Fig. 51. *Achromoporus enneryensis.* Gonopods.

Gonopods as shown in figure 51; the anterior division on each side with the apex slender, acute, and bent inward, the margin below it descending straight to the base; posterior division on each side with the posterior arm very broadly blade-like, the apex blunt.

Anterior male legs with the prominence on the ventral side of the third joint almost obsolete, reduced to a very inconspicuous swelling.

Achromoporus furcipes new species

A male (type) and a female collected near Plaisance, July 8, 1927, C. & L. Numerous other males and females collected on Morne Pilboreau, between Plaisance and Ennery, May 24 and July 8, 1927. C. & L. Type in U. S. N. M. Paratype in M. C. Z.

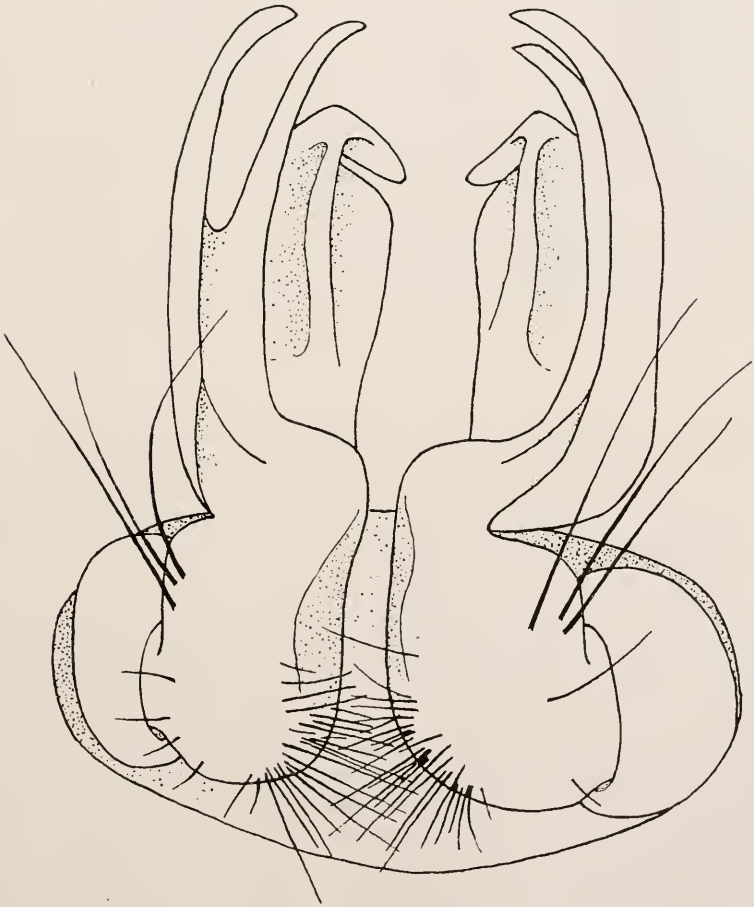


Fig. 52. *Achromoporus furcipes.* Gonopods.

Length 19 to 27 mm. Males of the same form as *A. ennerycnsis*, being more convex and less attenuated behind than in *A. coloratus*.

Most of the specimens are colorless but one or two are marked with brown as in *A. cuneryensis*.

Preanal scale with the sides straight from the lateral angles to the apex, without any suggestion of an emargination near the apex.

Second legs of both sexes with the inner corner of each coxal joint produced into a short, conic tubercle, more evident in the males.

Sternum between the third legs of both sexes with a conic tubercle on each side of the median furrow, the tubercles higher and more noticeable in the males; in some females scarcely evident.

Gonopods as shown in figure 52; the anterior division of each side terminating in a stout lobe directed inward and forward, the mesial margin below the lobe produced as far inward as the apex of the lobe and then descending; each posterior division with the two furcations slender and subequal in size and length, their tips acute, the cleft between the branches deep and rounded.

Anterior legs of the males with the prominence on the ventral side of the third joint scarcely evident, represented by a slight swelling.

Achromoporus robustus new species

Two males (1 the type) collected near Cancoque, May 13, 1927, L. One male collected near Plaisance, July 8, 1927, C. & L. Type in U. S. N. M. Paratype in M. C. Z.

Length 20 to 22 mm. Body of the males much more convex than in any of the other species here described, and not attenuated behind the third segment as in those species but with the sides of the body parallel.

All specimens a waxy white throughout.

Preanal scale with the apex very definitely produced into a slender tip; from its base to the lateral angles the sides are nearly straight. (Fig. 53, *a*).

Coxae of the second legs and sternum between the third legs as in *A. furcipes*, the tubercles of the sternum are scarcely as large as in that species, however.

Gonopods as shown in figure 53, *b;* the two branches of the posterior

division shorter and stouter than in *A. furcipes* and the cleft between them more acute.

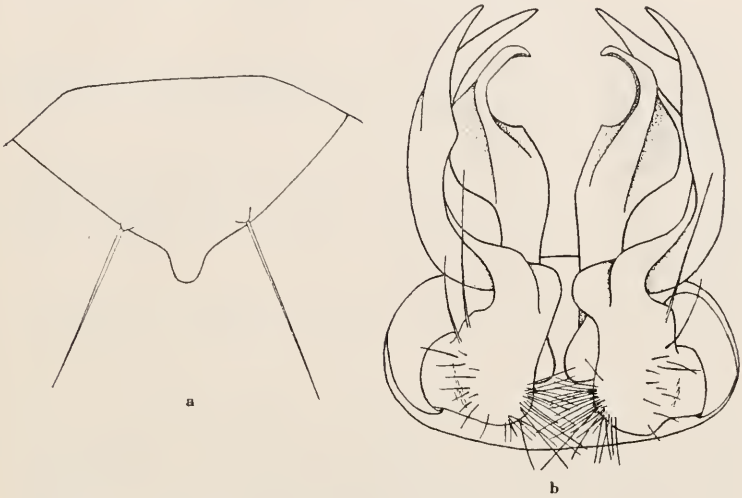


Fig. 53. *Achromoporus robustus*. *a*, Preanal scale; *b*, Gonopods.

Anterior legs with the prominence on the ventral side of the third joint less conspicuous than in *A. coloratus* but more noticeable than in the other species.

Amphelictogon Chamberlin

Amphelictogon manni Chamberlin

Amphelictogon manni Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 231, 1918. Diquini, near Port-au-Prince, is the type locality. The type is a female which has not been seen.

Considerable collecting was done in and near the type locality in the hope of rediscovering this species, but without success. The color pattern seems to be quite distinctive. It is assumed that there is a tooth on the posterior margin of the keels, as in the other members of the genus. No other species of this predominantly Cuban genus has been found in Hispaniola, and the inclusion of *manni* may be questioned, but the point cannot be settled without examining a male specimen.

Chondrotropis new genus

Type *Chondrotropis niger* new species.

Body moderately long; both sexes with the sides converging caudad from the second or third segment, more strongly so in the males than in the females; dorsum of the males more flattened, the lateral carinae more horizontal and projecting farther.

Head with a deep groove extending across the vertex to between the antennae. Antennae with joint 2 slightly longer than any of the others, joints 3 to 6 inclusive nearly equal, joint 3 sometimes a little longer than the others except joint 2.

First segment with the anterior margin nearly straight to broadly rounded; the posterior margin extensively emarginate at middle.

Ensuing segments to near the posterior end of the body with 2 to 8 small, broadly conic tubercles scattered on the dorsal surface of the keels, the apex of each tubercle with a tiny punctation. In some specimens the tubercles are obsolete on some of the segments, particularly those toward the posterior end of the body. Surface, except for the tubercles, smooth and shining but with moderate magnification visibly reticulated and longitudinally scratched.

Beginning on segment 2 and not extending beyond segment 9 there is a small, acute tooth projecting from the lateral margin of each keel just behind the anterior corner.

Pores of the customary segments.

Anal valves with high, thick margins; the disc of each valve strongly convex and with the seta located between the middle and the basal third, rather close to the raised margin.

Preanal scale rounded-triangular, the apex slightly produced.

Gonopods with each anterior division either deeply bifurcate or simple, in the latter condition the outer branch appearing to have been reduced to a broad, angular prominence on the side of what corresponds to the inner branch; in the other species each posterior division with the base stout and from its apex a long, slender prong curves outward, upward and then inward, the more or less attenuated extremity slightly surpassing the anterior division.

The gonopods projecting through an oval opening surrounded by a raised rim much higher on the sides than behind.

Second male legs with the inner corner of each coxa produced into a conic tubercle, coxae of the second legs of the females simple.

Sternum between the third male legs narrower than that of the

female and with the sternal prominences much closer together, sometimes adnate to near their apex.

The three species are separated in the following key.

Key to the Species of Chondrotropis

Color of the poriferous keels white, the nonporiferous keels brown.... *venustus* new

No striking color differences between the poriferous and nonporiferous segments.....

General color black or brownish-black, sometimes relieved by dorsal colored areas ranging from reddish-brown to reddish-yellow *niger* new

Animals distinctly bicolored, red or pink, and white.....*pictus* new

CHONDROTROPIS NIGER new species

Numerous males and females found crawling over rocks at the base of a cliff near the road below Ennery, July 7, 1927, C. & L. Type in U. S. N. M. Paratype in M. C. Z. A male, badly broken, collected at Dondon, Jan. 1926, by E. C. Leonard.

Length usually 26 mm.; the males as long as the females but more slender, with the sides definitely narrowing from the third segment to the caudal end of the body; females with the sides slightly narrowed; lateral carinae of the males projecting farther, more depressed and horizontal than those of the females.

Living color of the males shining black, sometimes with a brownish cast; head black; dorsum of each segment from the first to the penultimate inclusive with an inconspicuous brown spot in front of the posterior margin at middle; posterior portion of the poriferous carinae reddish-brown; ventral surfaces, legs and antennae almost black. Females distinctly browner than the males; first segment with the lateral corners and a median anterior and posterior spot light reddish-yellow, the spots sometimes connected; ensuing segments each with a round-quadrate spot of reddish-yellow on the middle of the dorsum limited behind by the posterior margin; posterior corner of the lateral carinae yellow or reddish-yellow; much of last segment rather light brown; anal valves and preanal scale dark; antennae and legs with the proximal joints light brown, the outer ones darker; ventral surfaces quite light brown.

Head with the groove of the vertex long and deep, the surface on each side of it notably swollen; from the lower, outer side of each

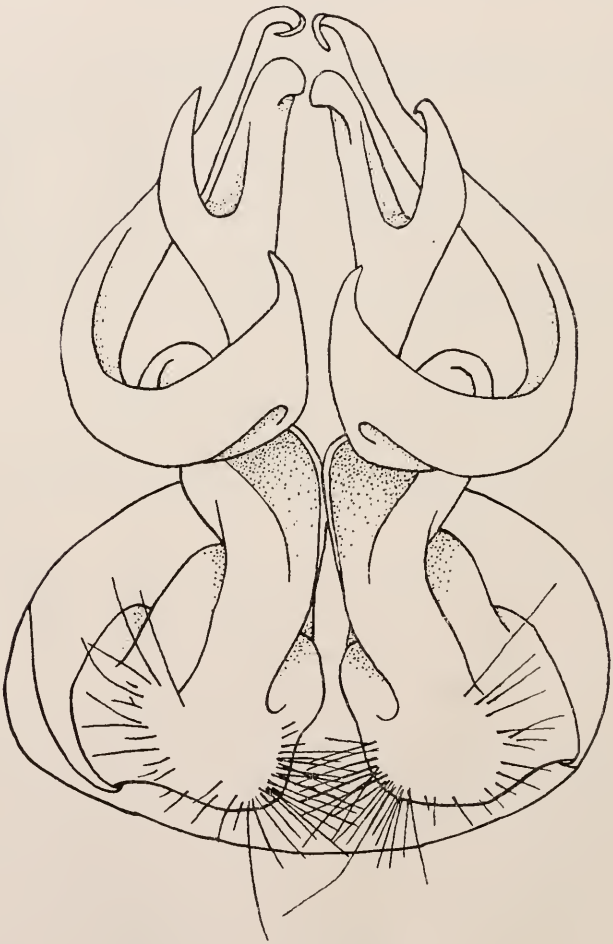


Fig. 54. *Chondrotropis niger*. Gonopods.

antennal socket a short, deep groove usually extends forward half way to the corner of the clypeus. Antennae with the third joint slightly longer than any of the three that follow.

First segment with the margin behind the head nearly straight, scarcely rounded; posterior margin broadly and quite deeply emarginate at the middle; lateral corners somewhat less than right angles.

From segment 2 sometimes as far back as segment 9 an acute tooth projects from the margin of each keel just behind the anterior corner.

Beginning with segment 2 and usually extending onto the third segment at the posterior end of the body there are 5 to 8 low, rounded tubercles, varying from small to very tiny, scattered over the dorsal surface of each keel and the adjacent side of the dorsum, the apex of each tubercle shining and with a tiny punctation in the center; surface of the segment elsewhere shining but moderate magnification shows definite reticulations and a few longitudinal scratches.

Anal valve with thick and very high margins, the disc of each valve with numerous straight, impressed lines extending obliquely inward and downward toward the preanal scale; seta located just above the basal third and close to the margin.

Gonopods as shown in figure 54; the two branches of the anterior division on each side terminate in slender tips, as does the apex of each posterior division, only the latter is longer and more attenuated.

Second legs of the males with the inner corner of each coxa produced into a rather high, broad, conic tubercle which is replaced by a rounded corner in the females.

Sternum between the third male legs narrower than in the females and with the two low, tumid prominences much closer together, almost touching.

Chondrotropis pictus new species

Plate 2. Fig. 2

One male (type) collected on Morne Pilboreau, above Ennery July 7, 1927, and another male and a female collected in the same locality the next day. C. & L. A female also was collected here May 24, 1927. L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Very closely related to *C. niger* but differing principally in coloration. The males are less depressed and the processes of the sternum of the fourth male segment are adnate nearly to the tips and form a single, large median swelling instead of two submedian cones.

Description. Length 26 to 32 mm.; males more attenuated behind than the females and with the dorsum flatter, the lateral keels more

projecting and somewhat depressed, but not as much as in the males of *C. niger*.

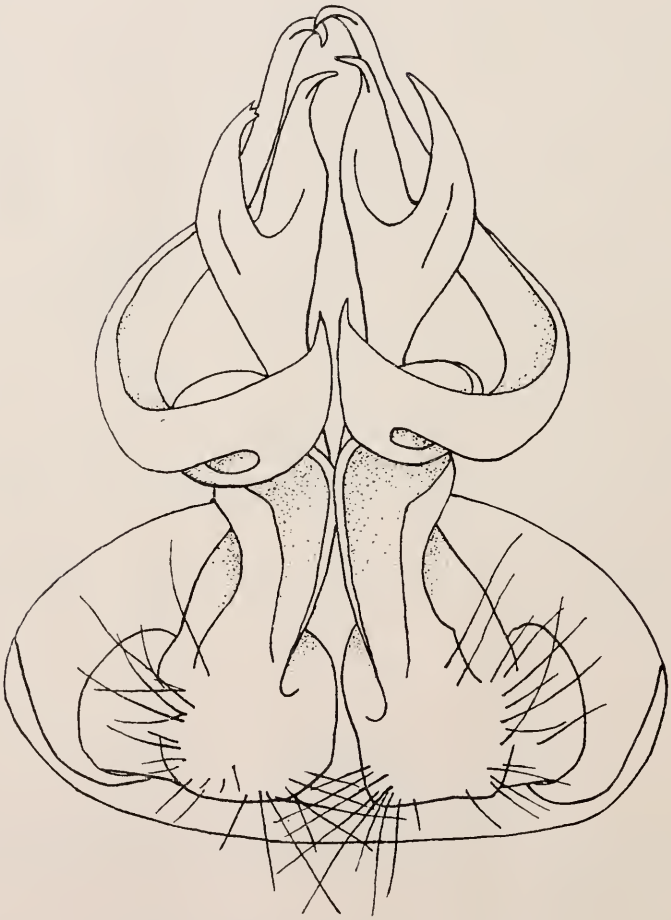


Fig. 55. *Chondrotropis pictus*. Gonopods.

Living color light red or pink, and white. Head dark brown, except the clypeus and labrum which are light yellow; antennae with the basal joints pale pink, the outer joints light red. First segment pink, except for 2 rather large transverse and sometimes confluent brown areas on

the disc. Ensuing segments with the keels reddish-pink, except the anterior margin and corner which are light brown; on the poriferous segments the pink area is larger and the brown area is smaller than on the nonporiferous segments; base of the keels and the sides of the body, where they are joined by the keels, chestnut brown as are the sides of the anterior subsegments between the keels and the ventral surfaces, half way to the legs; the remainder of the ventral surfaces nearly white; dorsum of the anterior and posterior subsegments nearly white, the former with an elongate-oval spot of brown on the median line, the latter with the posterior two-thirds tinged with pink. Last segment light brown, the tip with a pink cast. Anal valves light brown, the preanal scale still lighter. Legs very light red, the basal joints particularly so.

Head with the groove of the vertex as long as in *C. niger* but not as deep, the surface on each side of it only moderately inflated; surface below the antennal sockets smooth and broadly concave, but with no indication of a distinct groove as in *C. niger*.

First segment with the anterior margin broadly rounded, the emargination at the middle of the posterior margin broad but more shallow than in *C. niger*.

Segment 2 to segment 4, 5 or 6 with an acute tooth projecting from the lateral margin of each keel just behind the anterior corner.

Keels of the segments with the tubercles on the dorsal surface reduced in size and number, seldom more than 4, sometimes they are nearly or completely obsolete on some segments.

Anal valves with the margin moderately high; disc of each valve with scarcely any oblique furrows. Preanal scale as in *C. niger*.

Gonopods closely resembling those of *C. niger*, as reference to figure 55 shows, however, the inner branch of the anterior division of each gonopod has a much less acute apex, which also is bent caudad as well as mesad; the lower inner corner of the basal portion of each gonopod appears to be more densely hairy then in *C. niger*.

Second legs of the male with the inner corner of each coxa produced into a short, conic swelling which is represented by an inconspicuous angle in the female.

Sternum between the third male legs narrow, with a low, rounded swelling in the middle, formed by the coalescence of the 2 conic tubercles which usually are present; the median furrow is represented by a shallow, knife-like cut across the summit of the swelling. Females with the sternum wider and with a rather broadly conic tubercle on each side, the tubercles widely separated by the median furrow.

Chondrotropis venustus new species

Plate 2, Fig. 3

One male (type) and 3 females collected on Morne Brigand, near Bayeux, July 16, 1927. L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. This is perhaps the handsomest of the Hispaniolan millipeds; the white keels of the poriferous segments contrast strongly with the dark chestnut brown of the dorsum, and the alternation with the dark keels of the nonporiferous segments is very striking and immediately distinguishes this species from the other two in the genus. The gonopods also are quite different, as comparison of the drawings shows.

Description. Length 32 to 36 mm.; the male a little flatter and more attenuated behind than the females, the lateral carinae only a little more projecting and depressed.

Living colors white and chestnut brown. Head dark brown, except on the sides and the clypeus which are light brown. First segment narrowly yellowish-brown along the front margin at the middle, behind which is a large dark brown area of the shape of 2 equilateral triangles, with their bases toward the front, their inner corners joined, the outer corner of each reaching the lateral margin and the apex reaching the posterior margin some distance from the middle; thus the design of the remainder of the segment is 3 subtriangular areas of white, one including each lateral angle and the other between the dark triangles. Segment 2 dark brown, with a transverse white area extending inward from each posterior angle. Ensuing nonporiferous segments dark brown, with a lighter median area near the posterior margin and another less conspicuous one in front. Each of the poriferous segments with the keels and some of the adjoining surface of the dorsum pure white, the middle of the dorsum broadly dark brown, except a light area in front and behind on the median line. Last segment dark at base, the tip lighter. Anal valves and preanal scale dark brown. Anterior subsegments light, broadly brownish-yellow at the middle with a narrower darker median line showing through the integument. Sides of the body below the keels dark half way to the legs, the remainder of the ventral surface dirty white. Antennae and legs nearly cherry red.

Head much as in *C. pictus*. Antennae with joint 2 slightly longer than any of the others; joints 3 to 6 inclusive subequal in length.

First segment broadly rounded in front, the posterior margin broadly and moderately deeply emarginate at the middle.

Segments 2 to 4 inclusive with a tiny tooth on the lateral margin of each keel just behind the anterior corner.

Fig. 56. *Chondrotropis venustus*. Gonopods.

Keels of the segments with 2 or 3 broad, low, inconspicuous tubercles on the dorsal surface, the tubercles frequently entirely lacking from some segments; surface otherwise as in the other 2 species.

Anal valves with the margins thick and moderately high; the disc of each valve strongly furrowed obliquely downward and inward toward the scale, seta nearly opposite the middle of the raised margin. The preanal scale as in the other 2 species.

Gonopods as shown in figure 56; each anterior division long and quite simple, a broadly triangular projection from the middle of the outer side representing the branch which is present in the other 2 species; each posterior division with the distal half shorter and more evenly curved from the base to the apex and with the apex not as greatly attenuated as in the other species.

Second male legs with the inner corner of each coxa produced into a short and broadly conic tubercle; females with the same corner broadly rounded instead of produced.

Sternum between the third legs of the male narrow, with 2 rather high, closely placed conic tubercles separated by the median furrow. Sternum of the female broader and with lower, broader conic tubercles more widely separated.

Sterna of the fifth segment of the male broad and with 2 large, rounded elevations between each pair of legs, separated by the longitudinal median line. Females with the sterna broader and without elevations.

Beatadesmus Loomis

Beatadesmus utowani Loomis

Beatadesmus utowani Loomis, Smiths. Misc. Coll., **89**, no. 14, pp. 31 & 32, 1934.
Collected on Beata Island, off the south coast of Hispaniola.

Quisquicia new genus

Type. *Quisquicia scitula* new species.

Diagnosis. Many structural features of *Beatadesmus* associate it with *Quisquicia* but the similar color pattern of the segments with and without pores distinguish *Quisquicia*, although examination of males of *Beatadesmus utowani* may show all species of *Quisquicia* to be congeneric with it. The gonopods of *Aplopododesmus* and *Pogonodesmus* are suggestive of this genus but the pores open dorsally in the former genus and there is no pore callus in the latter genus.

Description. Body of medium size, from 20 to 30 mm. in length; males slightly more slender than the females.

Color pattern of all segments the same.

Surface of segments smooth in the type species but in the others it is variously granular, the males usually less granular than the females.

First segment with three transverse rows of setae. Ensuing segments with three transverse rows of setae, 6 to 8 setae in the front and middle row and 10 in the back row. Dorsum without a transverse depression, usually convex, the lateral carinae continuous with it. From segment 2 sometimes as far back as segment 15 or beyond, a tooth is present near the anterior corner of each carina. Posterior corners of the poreless carinae acute. Pores opening laterally from a large thickened callus occupying the back half of the lateral margin of the carina of the usual segments. Posterior margin of most segments usually with a definite tooth near the base of the carinae, teeth being strongly evident in all species except *Q. rubens*.

Sterna concave but not crossed in either direction by a distinct furrow.

Gonopods composed of two slender, subequal, divisions of notable simplicity as shown in the drawings of the species.

Pregenital legs and sterna with no special modifications.

The generic name is derived from one of the old native names for Hispaniola, "Quisquica."

Key to the Species of Quisquicia

Body of small size, not exceeding 20 mm. in length . . . . . *scitula* new
Body of large size, 25 to 35 mm. in length . . . . . .
Dorsum apparently smooth; segments lacking distinct teeth on the posterior margin . . . . . *sallei* (Saussure) [1]
Dorsum distinctly granulated or tubercular; some segments with one or two teeth on the posterior margin near the keel . . . . . .
Head everywhere setose except at the highest part of the vertex; outer margin of non-poriferous carinae with several teeth . . . . . *engonata* new
Head glabrous except on the front; outer margin of non-poriferous carinae never with more than one tooth . . . . . .
Color black and cherry red; a conspicuous tooth at the anterior corner of segments 2, 3 and 4; pore callus much swollen . . . . . *insignis* (Chamberlin)
Color apparently nearly solid throughout, reddish, with no trace of black; an inconspicuous tooth at the anterior corner of segments 2, 3 and 4; pore callus much less swollen . . . *rubens* new

[1] The characters given in this key for *Q. sallei* were derived from Saussure's drawing of the species.

Quisquicia scitula new species

Plate 1, Fig. 4

Many specimens of both sexes crawling over rocks and tree trunks collected north of Trouin, June 26, 1934 by E. M. Loomis. Type in M. C. Z. Paratype in U. S. N. M.

Description. Length 20 mm., width 2.5 mm.; males more slender than the females; segments strongly convex transversely, the lateral carinae well below the level of the dorsum.

Living color deep brown, almost black, and creamy white. Head dark above, light below. First segment white around the margin, the inner dark area transverse, medianly constricted in the form of a pair of spectacles. Ensuing segments with the anterior subsegments dark brown throughout; posterior subsegments with the front half, including the carinae, entirely dark brown, the back half with the hind corners of the carinae white, adjacent dorsum dark with the median portion white; this white area is in the shape of a transverse rectangle. Last segment dark at base, white at apex. Ventral surfaces dark in fully colored specimens.

Head smooth, the vertex with a pronounced furrow; antennae rather short, being incapable of reaching beyond segment 2; joints 2 to 6 inclusive of equal length and thickness.

First segment of the usual semi-circular shape, with an anterior row of 10 setae erected from the smooth surface. Several pits in the inner surface apparently indicate where other setae have been.

Segment 2 with a tiny tooth at the front angle of each keel; larger teeth are present on the ensuing keels to about segment 15 in the males and segment 8 in the females. (Fig. 57, *a*.) Posterior corners of the non-poriferous segments acute. Pores opening laterally from a large, thickened callus occupying the posterior half of the lateral margin of the keel. Posterior margin of segment 4 to segment 16 or 17 with a large tooth adjacent to the keel in the male; in the females these teeth are much reduced in size and are scarcely evident beyond the middle of the body. Surface of the dorsum smooth and shining, sometimes with a few tiny tubercles on the surface of the keels which possibly may indicate that setae were present in unrubbed specimens as about 10 setae are present along the posterior margin of segments 18 and 19 where they are borne on similar minute tubercles. Lateral carinae not projecting far from the sides of the body on the anterior segments and on the posterior segments they are even more greatly reduced, only the poriferous calluses or the posterior angles of the non-poriferous segments projecting.

Anal valves distinctly rugulose vertically; with smooth raised margins.

Prenal scale triangular, the two setae on tiny submarginal tubercles.

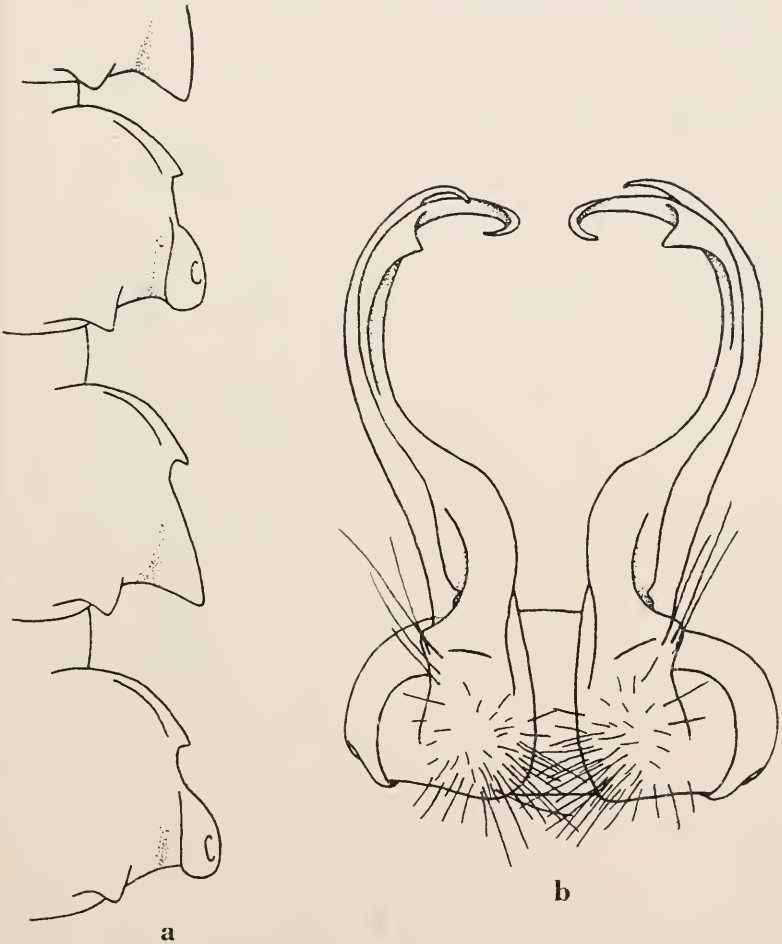


Fig. 57. *Quisquicia scitula*. *a*, Lateral carinae of segments 4 to 7; *b*, Gonopods.

Sterna nearly glabrous, concave at center but without an impressed furrow in either direction.

Gonopods as shown in figure 57, *b*.

Pregenital legs of the male unmodified.

Quisquicia engonata new species

A mature male and female and a young male collected at Roche Croix, Morne La Hotte, at 5000 feet elevation, Oct. 13, 1934 by P. J. Darlington. Type and paratypes in M. C. Z.

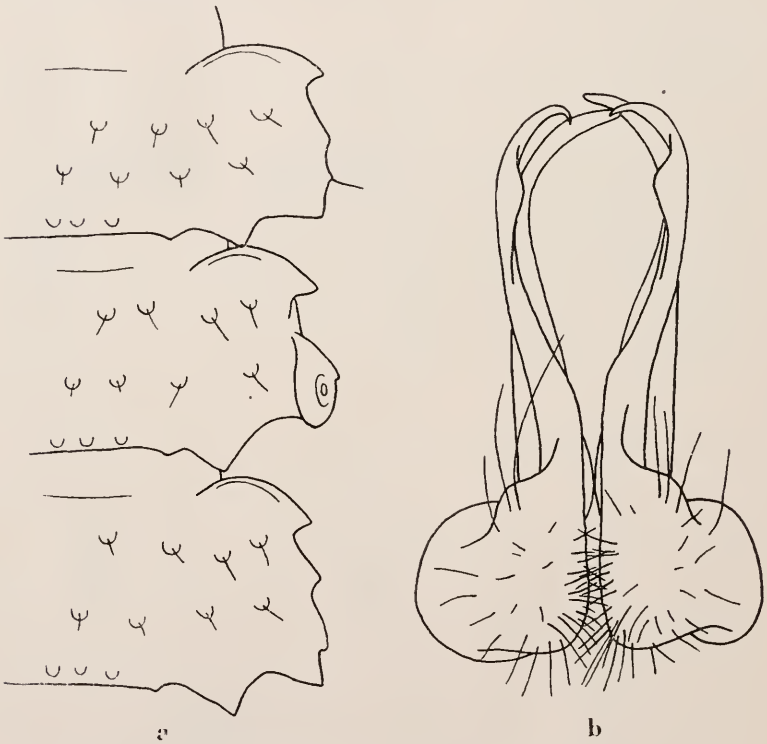


Fig. 58. *Quisquicia engonata*. *a*, Right half of segments 4, 5 and 6; *b*, Gonopods.

Diagnosis. The form of the gonopods indicates close relationship with *Q. scitula* but the body is larger; the dorsum bears setiferous tubercles; the lateral carinae are level with the dorsum and project farther from it.

Description. Length of the type 27 mm. No striking differences between the sexes in the shape or sculpturing of the body. Body with the lateral carinae horizontal, high on the sides, continuous with the

flat dorsum from which they project strongly on all segments. The specimens are creamy white but it is doubtful if this was the color in life.

Head everywhere beset with upright setae except on the highest part of the vertex; antennae long and slender.

First segment semi-circular; with an anterior row of 10 setae rising directly from the surface, a median row of 8 setae rising from faintly indicated elevations, and a posterior row of 10 setae rising from low but distinct tubercles well in advance of the back margin. Just in front of the posterior corner of the carinae three setae project outward from the margin.

Second and ensuing non-poriferous segments with an acutely prominent tooth at the anterior corner of the carinae; between this and the posterior corner the margin is more or less plainly bidentate, a stiff seta projecting from each tooth; posterior margin of the carinae with a large tooth near the squarely angled outer corner, a smaller tooth near the base of the carina. Surface of this and ensuing segments with three transverse rows of tubercles, the anterior and middle rows each composed of eight large setiferous tubercles extending onto the lateral carinae; the third row contains six smaller, inconspicuous tubercles close to the posterior margin between its innermost teeth, the tubercles, in the specimens at hand, without setae except on the three segments preceding the last. Poriferous segments with the callus large and conspicuous, preceded by the very acute anterior corner of the carina; pores opening outward. The right hand half of segments 4, 5 and 6 is shown in figure 58, *a*.

Sterna more hispid than those in the genotype.

Gonopods quite similar to those of the genotype but they are much straighter, as shown in figure 58, *b*.

Quisquicia insignis (Chamberlin)

Caraibodesmus insignis Chamberlin, Bull. Mus. Comp. Zool., **62**, p. 234, 1918.

One male and three females collected in rotting Yucca stumps above Kenscoff, June 24, 1934, by E. M. and H. F. Loomis.

This species was based entirely on females and as no other congeners were definitely known in Hispaniola it was placed in the genus *Caraibodesmus*. The recent finding of males shows the species to belong in the present genus with three newly described species and a fourth species, *Polydesmus sallei* Saussure, tentatively included. Considerable uncertainty surrounds this latter species as no specimens have

been seen by the writer, nor has it been reported from Hispaniola by others since it was described.

Notes on the above specimens of *Q. insignis* are given below.

Largest female 30 mm. long and 3.5 mm. wide; the male is more slender and slightly flatter.

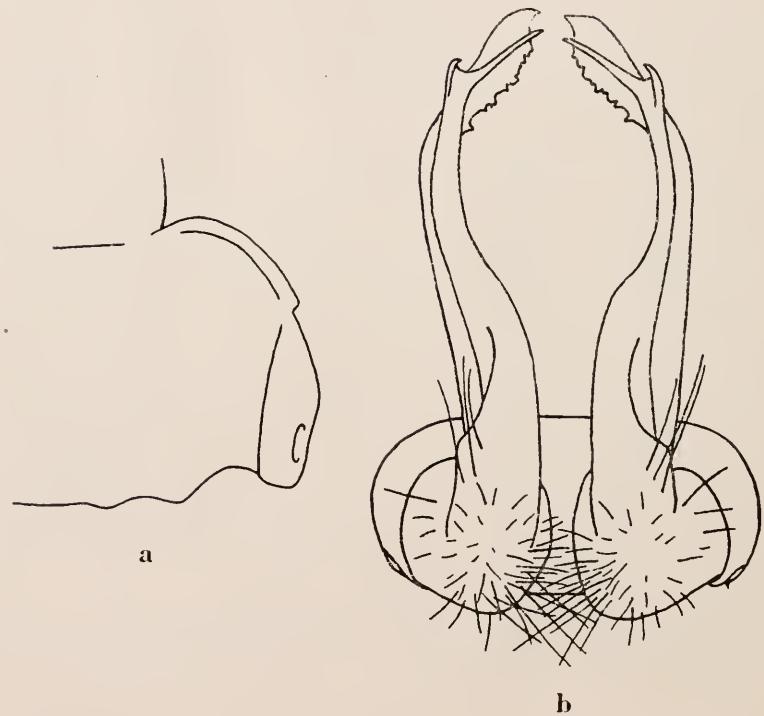


Fig. 59. *Quisquicia insignis*. *a*, Lateral carina of segment 5 of female; *b*, Gonopods.

Segments with dorsal setae as in the type species; they are present along the anterior margin of segment 1; and on segment 18 and 19 there is an anterior row of about 8 setae, a median row of 6 setae, and 10 setae along the posterior margin.

The tuberculation of the females is about as given by Chamberlin except that none of the specimens show "ridge-like folds traceable forward nearly entirely or else entirely across the metazonite." The

male has the dorsum almost smooth in conspicuous contrast to the females; only on the last segments are there any indications of the larger tubercles and there are none of the fine granules so evident on segments 1 to 6 or 7 of the females.

Male with a faint tooth on the posterior margin of the segments behind the middle of the body close to the carina.

Pores opening from a thickened callus which is preceded by a much less evident marginal ridge than in *Q. scitula*, and which ends in a rounded angulation instead of a distinct tooth-like corner. Lateral carina of segment 5 of a female is shown in outline in figure 59, *a*.

Sterna concave, not furrowed in either direction, beset with 20 to 30 scattered hairs.

Gonopods as shown in figure 59, *b*.

Pregenital male legs normal.

Segments 3 and 4 with the serrate ridge on the latero-ventral surface much lower and less conspicuous than in *Q. scitula*. Sides of body below the keels finely granular in the females; smooth in the male.

Quisquicia rubens new species

One female collected on Morne La Selle, at 7,500 feet, by A. Audant. Type in M. C. Z.

Diagnosis. Unicolorous in contrast to the closely related *Q. insignis;* also the pore calluses are less prominent and the preanal scale has the apex produced into a small accessory lobe.

Description. Length 30 mm., width 3.5 mm.

Color of the alcoholic specimen reddish brown throughout, without any trace of black.

Head with the vertex coarsely wrinkled; median furrow deep, the surface on each side of it definitely swollen; front hispid from between the antennae to the labrum; antennae with joints 2 to 6 subequal in length.

First segment with anterior margin raised into a narrow rim; posterior margin triarcuate; surface with many tiny scattered tubercles and three rows of larger ones, each tubercle with a tiny pit from which a seta probably projected, as on the ensuing segments similar tubercles occur, and on the penultimate segment several setae remain on the tubercles; on this segment there are about 8 tubercles in the anterior row, 6 in the middle row, and 10 along the posterior margin.

On the ensuing segments the anterior row contains about 6 tubercles, the middle row 6 to 8, and the posterior row 8 to 10 tubercles; on some segments the outer tubercle of the posterior row is developed into a small, slightly produced tooth. Segments 2, 3 and 4 with a small tooth on the lateral margin of the keels near the front corner; no tooth on segment 5, one side of which is shown in figure 60. Body

Fig. 60. *Quisquicia rubens.* Lateral carina of segment 5 of female.

with the dorsum evenly and moderately convex; the lateral carinae continuous with it; carinae or keels narrow, extending but a short distance from the side of the body. Pores opening laterally from a marginal callus which is less swollen than in *Q. insignis.*

Preanal scale sub-triangular, the sides rounded somewhat and the apex produced into a short accessory apex.

Sterna slightly hispid.

Quisquicia sallei (Saussure)

Polydesmus sallei Saussure, Faun. Myr. Mex., p. 42, 1860.
Odontopeltis sallei Pocock, Jour. Linn. Soc. Lond., **24**, p. 512, 1894.
Leptodesmus sallei Silvestri, Bull. Amer. Mus. Nat. Hist., **24**, p. 575, 1908.
Caraibodesmus (?)*sallei* Chamberlin, Bull. Mus. Comp. Zoöl., **62**, no. 5, p. 236, 1918.

Although Saussure gave Santo Domingo as the only definite locality, the species has not since been identified from Hispaniola. Pocock indicated that he had seen no specimens and his report was based entirely on that of Saussure. Silvestri reported the species from Puerto Rico but if the species really belongs to the Hispaniolan fauna it would be remarkable to find it in another island, as most of the large species of this order are confined to single islands.

Pogonodesmus new genus

Type. *Pogonodesmus pullus* new species.

Diagnosis. In spite of the similarity of the gonopods of this species with those of the genotype and a related species of *Quisquicia* the prominent pore calluses of that genus exclude the present species. The transverse rows of setiferous tubercles and the shape of the gonopods prohibit its inclusion in other genera in which the pores open from the carinae in a similar fashion.

Description. Body moderately long, median portion with sides parallel. Males more slender and with more projecting lateral carinae than the females but with less surface sculpturing. Lateral carinae horizontal, high, near the level of the dorsum. Legs long and slender, much exceeding the sides of the body, especially in the males.

Head completely invested with short, erect hairs; vertex deeply grooved; antennae long and slender.

First segment nearly semi-circular, the anterio-lateral margins raised; posterior corners acute; dorsal surface with three transverse rows of setae.

Segments 2 to 5 or 6 with a small tooth at the anterior corner of the lateral carinae. Segments 2 to 19 with three transverse rows of broad and low tubercles each bearing an apical seta. The dorsal and lateral surfaces of the anterior female segments also are densely and coarsely granular or nodular, the granulations lessening toward the rear end of the body. Pores on the usual segments, opening outward from the thickened margin instead of being borne in a special callus.

Last segment produced into a deflexed apex surpassing the anal valves. Valves with thickened and elevated margins. Preanal scale acute behind.

Sterna setose in both sexes.

Gonopods consisting of two slender, erect, quite similar, subparallel joints.

Anterior legs and sterna of both sexes without secondary sexual modifications.

Pogonodesmus pullus new species

A male and female collected at Kenscoff, between 3000 and 6000 feet elevation, Nov. 1, 1934 and a female from La Vestite, La Selle range, Sept. 16–23, 1934 by P. J. Darlington. Type and paratypes in M. C. Z.

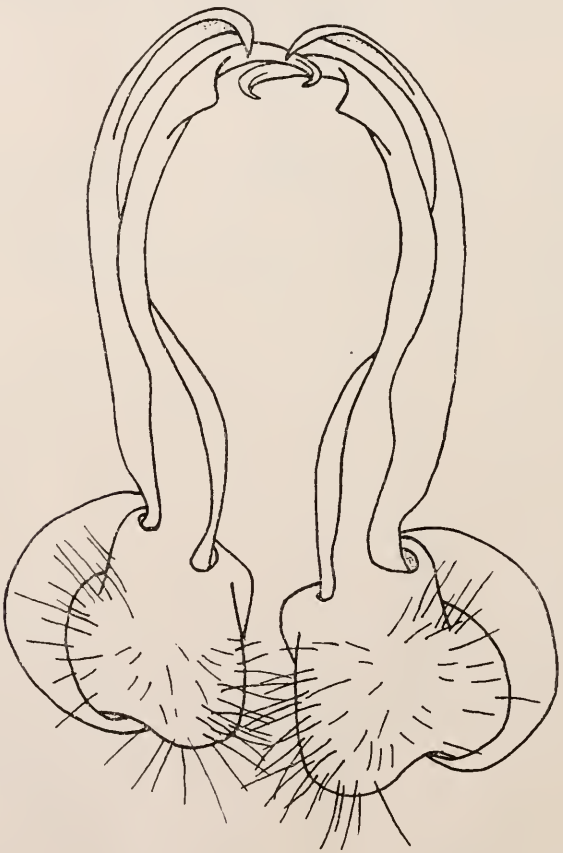


Fig. 61. *Pogonodesmus pullus.* Gonopods.

Description. Length from 32 to 38 mm. Male with more slender body than the female but with lateral carinae projecting farther from the body so that with animals of the same length the two sexes are of subequal width across the back. The male carinae are more elevated,

being level with the middle of the dorsum, and the posterior angles are produced farther caudad, but the females have the dorsal surface densely tubercular whereas the male is smooth except for the three transverse rows of low and broad setiferous tubercles which also are present in the females. In color the posterior corners of the carinae and the posterior half, or less, of the dorsum dark red, elsewhere black; head narrowly red in front, elsewhere black; antennae, legs, and ventral surface light colored.

Antennae long and slender; joints 2 to 6 inclusive subequal in length.

First segment with eight setae close together behind the median portion of the front margin; eight setae in the median row and ten in the row across the posterior quarter. In the males the surface is entirely smooth, the setae not being on tubercles as on the ensuing segments; in the female the surface is densely and finely tuberculate or nodular above and on the sides below the lateral carinae, as are the ensuing segments to near the middle of the body where the tubercles gradually become less apparent except those tubercles bearing the setae which increase slightly in size and prominence; latero-ventral surface of the posterior female segments smooth.

Segments 2 to 19 with an anterior and a median row of setiferous tubercles, six to eight in each row, and a posterior row of ten setiferous tubercles near the margin. In the male the median surface of the carinae is broadly swollen into an evident prominence not to be seen in the female.

Gonopods as shown in figure 61.

Aplopododesmus new genus

Type. *Aplopododesmus longipes* new species.

Diagnosis. This genus may be intermediate between *Cyrtaphe* and *Beatadesmus*. It differs from *Cyrtaphe* in the hispid dorsum; toothed margins of most segments; and in having both pairs of gonopods of similar shape. The pores of *Beatadesmus* are surrounded by a thick rim and open laterally whereas in the present genus the pores open on the dorsal surface in a deep depression. From the broken specimens on which *Beatadesmus* was described it was impossible to determine whether or not the dorsal tubercles bore setae, but if not, the condition would constitute a difference.

Description. Body almost seven times as long as broad; widest at segment 2 or 3. Carinae set high on the sides of the body, surface slightly irregular; the dorsum between the carinae flattened, smooth.

Head with a deep furrow on the vertex; anterior surface hispid. Antennae close together, about double the width of the body in length.

Segments with three transverse rows of setae rising directly from the surface instead of from tubercles; dorsum without a transverse depression. Segments 2 to 17 or 18 with a strong tooth on the outer margin of each carina. Segments 4 or 5 to 17 or 18 with teeth on the posterior margin. Segments 17 and 18 with the carinae strongly produced backward, those of segment 19 very much smaller. Pores on the usual segments, opening in a large depression on the surface of the posterior corner of the carina.

Legs long and slender, greatly exceeding the sides of the body. Sterna finely setaceous. All legs similar in the sexes.

Gonopods somewhat like those of *Cyrtaphe* but the anterior and posterior pairs are almost identical in shape and length, being long, slender, and terminating in drawnout points.

Aplopodesmus longipes new species

A number of specimens, most of which are badly broken, were collected at 7,500 feet on Morne La Selle by A. Audant. Other specimens from La Vestite, La Selle range, 6000–7000 feet elevation, Sept. 16–23, 1934 by P. J. Darlington. Type and paratypes in M. C. Z.

Description. Length of an unbroken female 35 mm., width 5 mm.; males apparently of same size and proportions.

The color appears to have been light red or brown with the lateral carinae and the posterior margin of the dorsum slightly lighter; poriferous segments similar to the others.

Head with the deep furrow of the vertex terminating between the antennae; two large setae on each side of the furrow at the middle of the vertex; smaller setae are scattered over the front of the head from between the antennae to the clypeus. Antennae slender and about double the width of the body in length; joint 2 slightly longer than the others; joints 3, 4, 5 and 6 subequal.

First segment semicircular, with a narrow raised anterior rim; posterior margin triarcuate; surface smooth but with 25 to 30 erect setae disposed around the segment just inside the margin, and across the middle.

Ensuing segments with dorsal setae in three transverse rows, 8 to 10 setae in both the anterior and median row, and 6 in the last row along the posterior margin between the carinae. (Fig. 62, *a*.) The setae of the first two rows on the carinae rise from tiny tubercles but

all those on the dorsum rise from the smooth surface. Lateral carinae set high on the side of the body, almost continuous with the flattened dorsum but set off from it by a shallow, indefinite, longitudinal depression. Carinae from segment 2 to segment 17 or 18 with a strong tooth on the outer margin some distance behind the anterior corner.

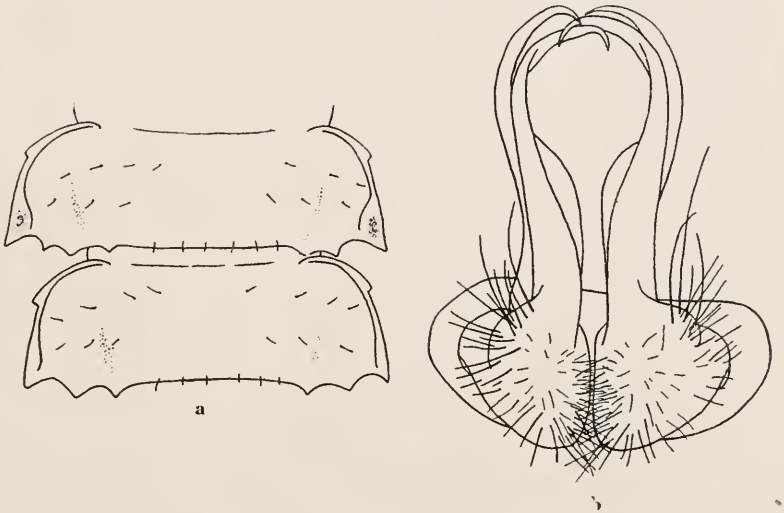


Fig. 62. *Aplopododesmus longipes*. *a*, Segments 5 and 6 of female; *b*, Gonopods.

Segment 4 or 5 to segment 17 or 18 with broad triangular teeth projecting from the posterior margin near the junction of the carina and the dorsum; the anterior segments have two or three teeth on each side; the midbody segments have two teeth each side; and the last segments have but a single tooth on each side; on all segments the outer tooth is the largest. Pores on the usual segments; opening obliquely into a deep depression in the dorsal surface of the posterior angle of the carina. Carinae of segments 17 and 18 large and extending backward, those of segment 19 very much smaller.

Last segment with a narrowed, produced apex much exceeding the valves.

Anal valves with margins high and thin, meeting at nearly their highest point instead of at a re-entrant angle.

Preanal scale large, triangular.

Gonopods as shown in figure 62, *b*.

Cyrtaphe new genus

Type. *Cyrtaphe alternata* new species.

Body slightly attenuated caudad from the fourth segment; the males more strongly so than the females; dorsum of the females moderately convex, the males notably flatter; lateral keels scarcely depressed, even in the males, in the females projecting nearly as far as those of the males, surface of the keels sometimes with several low, tiny, conic tubercles variously placed; surface of the dorsum elsewhere smooth and shining throughout. Pore formula normal.

Head with the usual groove on the vertex; anterior surface, from between the antennal sockets, with numerous rather long setae scattered over it; antennae with joints 2 to 6 inclusive subequal in length.

First segment with the anterior margin behind the head nearly transverse or broadly rounded; posterior margin emarginate at middle and in *C. continuata* with a slight emargination on each side between the angle and the median emargination.

Segments 3 to 5 sometimes with a very tiny tooth on the lateral margin of each keel.

Anal valves with the margins high and thick, the seta in each located near the dorsal fourth. Disc of each valve with the seta just below the middle of the valve. Preanal scale triangular, the apex more or less produced.

Gonopods with each anterior division a more or less simple, hooked structure, of variable width, the apex bending forward and outward; posterior division with the hirsute base short and only moderately stout, the apical portion almost continuous with it, quite slender, forming a long inwardly curved hook with a lobe of variable size projecting inward from the middle of the inner side.

Lateral rim of the opening for the gonopods much higher than the anterior or posterior rim.

Second legs of the males with the inner corner of each coxa slightly produced into a low rounded elevation.

Sternum between the third male legs with a definite, conic tubercle on each side, in the females a lower, less conspicuous prominence on each side.

Sternum between the fourth male legs with a very broad, rounded elevation on each side of the middle, the corresponding sternum of the females not at all elevated on the sides.

Pregenital legs of the males with the second joint much more swollen on the dorsal side than the same joint of these legs in the females.

Key to the Species of Cyrtaphe

Poriferous segments, almost as fully colored as those without pores; segments 3, 4, and 5 usually with a small but distinct tooth on each lateral margin behind the front angle..... *continuata* new

Poriferous segments with much less color than those without pores; none of the segments with a tooth on the lateral margin behind the front angle.....

First segment with scarcely any emargination of the posterior margin at middle; keels on some of the posterior segments with small tubercles on the dorsal surface; each anterior division of the gonopods with but a single lobe on the inner side between base and apex; each posterior division thin and rather broad..... *alternata* new

First segment with a short, deep emargination in the posterior margin at middle; none of the keels with tubercles on the dorsal surface; each anterior division of the gonopods with two lobes on the inner side between base and apex; each posterior division somewhat thicker, narrower, and more recurved... *lobipes* new

CYRTAPHE ALTERNATA new species

Plate 1, Fig. 5, Plate 2, Fig. 1

Numerous males (one the type) and females collected on Morne Pilboreau, above Ennery, April 5, 1926. Others from the same locality in 1925, C., and 1927, L. Type in U. S. N. M. Paratype in M. C. Z.

Body from 28 to 33 mm. long.

In alcoholic specimens the head has the vertex and the median part of the front, for a considerable distance below the antennae, dark chestnut brown; the sides of the head, clypeus and labrum yellowish-white. First segment with a rather narrow transverse brown spot near the anterior margin on each side; in fully marked specimens the spot begins at the middle of the front margin on each side and nearly reaches the other spot at the middle of the dorsum, the remainder of the segment white. Second segment with a brown spot on each side

in front, almost completely covered by the first segment but with some of the brown color diffused behind its margin. Third segment dark brown except the white lateral margins and the posterior angles, and

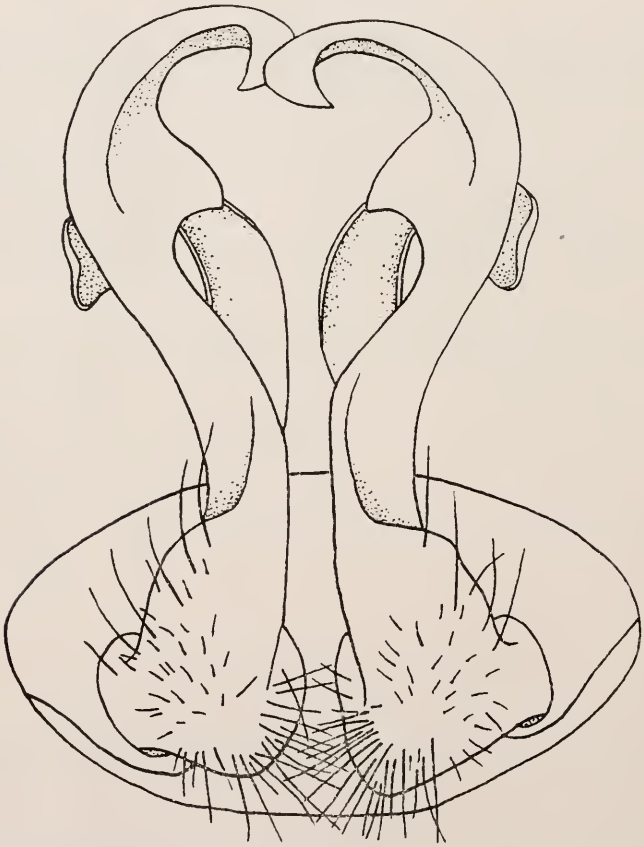


Fig. 63. *Cyrtaphe alternata.* Gonopods.

a brownish-white median area which is broader behind. Ensuing non-poriferous segments dark brown, with light brown lateral margins and a median area, which is broader near the posterior margin of each segment; the light margins and median area decreasing in size from the fourth segment backward. Poriferous segments uniformly white

throughout. Last segment in some specimens brown on each side in front. Sides of the body below the keels brown, grading to white near the base of the legs. Ventral surfaces, anal valves and preanal scale white. Antennae with the first joint white, the other joints light red. Legs with the basal joints colorless, the outer joints tinged with red.

First segment with the anterior margin scarcely rounded at the middle, almost straight across; lateral angle on each side moderately obtuse; emargination at the middle of the posterior margin very shallow.

None of the ensuing segments with a tooth on the lateral margin behind each anterior corner.

Surface of the segments smooth and shining. In some specimens a few small conic tubercles are more or less evident on the surface of the keels, particularly on the posterior segments.

Anal valves with the seta on the disc of each valve well removed from the raised margin; margins especially high, with setiferous tubercles on the outer sides of the margins rather than at or near their crests.

Gonopods with each anterior division broad and thin, the upper portion curving forward, outward and then backward, the apex broadly rounded; each posterior division with a broadly triangular lobe projecting inward from the inner side in front, some distance below the apex (Fig. 63).

Second legs of the males with the inner corner of each coxa slightly produced, forming a distinct shoulder which is completely lacking in the females.

Sternum between the third legs of the males narrower than in the females and with a much higher conic tubercle on each side of the median furrow and close to it; in the females the tubercles are broadly separated.

Sternum between the fourth legs of the males with a broader, higher, more rounded tubercle on each side than the preceding sternum, the tubercles beset with long setae. Sternum between the fourth female legs normal.

Cyrtaphe lobipes new species

One male (type) and four females collected at spring near Ennery, May 3, 1925. C. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Very closely related to *C. alternata* and scarcely to be distinguished from it in outward appearance. The gonopods, as shown

in the drawings of the two species, are quite different in several particulars.

Description. Body 28 to 31 mm. long.

Fig. 64. *Cyrtaphe lobipes.* Gonopods.

In the most fully colored alcoholic specimen the head is dark brown except for a narrow marginal area including the clypeus; antennae dark throughout but with the basal joint lightest. First segment mostly light colored, with a medium sized, transverse, brown spot on either side of the middle of the disc. Second segment brown on each side of the middle in front, median portion and the posterior half of

the segment light. Third segment intermediate in coloration between the second and fourth segment, the latter brown throughout except a light median line which is broader behind than in front. Ensuing nonporiferous segments brown throughout except the posterior angles and an indefinite area at the middle of the posterior margin. Poriferous segments mostly light colored, with an indefinite spot of the dilute brown in front at the middle; posterior poriferous segments lighter than the anterior ones. Last segment brown on the sides. Sides of body below the keels dark brown, slightly lighter near the legs. Anal valves brown on the sides. Preanal scale light brown. Legs tinged with red. Sterna light.

First segment more evenly rounded in front than in *C. alternata,* the emargination at the middle of the posterior margin shorter and deeper.

None of the ensuing segments with a tooth on the lateral margin behind the anterior angle. Surface of the segments smooth and shining and without tubercles on the surface of the keels.

Gonopods (Fig. 64) of much the same shape as those of *C. alternata;* but each posterior division with two lobes or prominences of the inner side between base and apex, the lower one corresponding to the lobe in *C. alternata* but smaller and terminating in a small, vertically bent hook; upper lobe the largest, triangular-acuminate, with no counterpart in *C. alternata.* Anterior divisions of the gonopods thicker than in *C. alternata* and more strongly recurved.

Legs and sterna on the anterior part of the body of the males and females not definitely different from those of the corresponding sex in *C. alternata.*

Cyrtaphe continuata new species

One male, the type specimen, and many females collected near Trouin, June 22, 1927, C. & L. A female, apparently of this species, was found at Port-au-Prince, May 30, 1923. L. A male and several females from near Trouin, June 26, 1934, E. M. and H. F. Loomis. Two males from Post Terre Rouge, Oct. 5, 1934 by P. J. Darlington. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. Readily distinguished from *C. alternata* by the continuously colored segments, those bearing the pores being almost as fully colored as the nonporiferous ones. The form of the first segment and the toothed margin of segments 3 to 5, as well as the shape of the gonopods are some of the most prominent structural peculiarities of this species.

Description. Body from 27 to 35 mm. long.

In life the head is dark chestnut brown, except on the lower sides

and on the labrum which are pink. First segment pink, with a transverse oval spot of dark brown on each side of the middle. Segments 2 to 4 inclusive with the keels and posterior half of each segment pink, the remaining anterior portion of the segment dark brown. The anterior poriferous segments are pink, with a large dark brown spot at the middle in front; posterior poriferous segments with the dark spot larger, reaching back nearly to the posterior margin and laterally to the base of the keels. Nonporiferous segments dark brown, except the pink posterior angles and a narrow area along the middle of the posterior margin which is pink. Anterior subsegments dark brown with a large pinkish-white area at the middle. Last segment pink at tip. Anal valves brown. Preanal scale light brown tinged with pink. Sides of the body brown, becoming lighter near the legs. Sterna and basal joints of the legs light pinkish, outer joints darker red. Antennae with the first joint light red, outer joints brownish-red.

First segment with the anterior margin evenly rounded from side to side; posterior margin with a broad, rather deep median emargination and a less conspicuous one each side between it and the lateral angle; lateral angles somewhat more acute than in *C. alternata*.

Third segment usually with a tiny tooth projecting from the lateral margin of each keel just behind the anterior corner. Segments 4 and 5 with decreasingly smaller teeth in the same position.

Surface of the segments in general smooth and shining but on some of the segments, particularly toward the back end of the body, a few tiny conic tubercles may be present on the surface of the keels.

Anal valves with the seta on each valve closer to the raised rim than in *C. alternata*, the raised margins slightly lower and thicker and the setiferous tubercles located nearer their crests.

Gonopods with each anterior division thickened and tapering gradually from the base to the apex, which is narrowly rounded and curves forward and outward; each posterior division with a broad, low, inconspicuous prominence near the middle of the inner side behind; apical portion of the division more slender and curved than in *C. alternata*, the actual tip more attenuated (Fig. 65).

Second legs of the males with the inner corner of each coxa with a slightly more developed shoulder than in *C. alternata;* females with coxae normal.

Sternum between the third pair of legs of the male narrower than in the females, with 2 broad, low, conic tubercles narrowly separated by the median furrow; in the females the tubercles are broader, lower, and more separated.

Sternum between the fourth pair of legs of the males with a low, broadly rounded, setiferous elevation on each side of the middle.

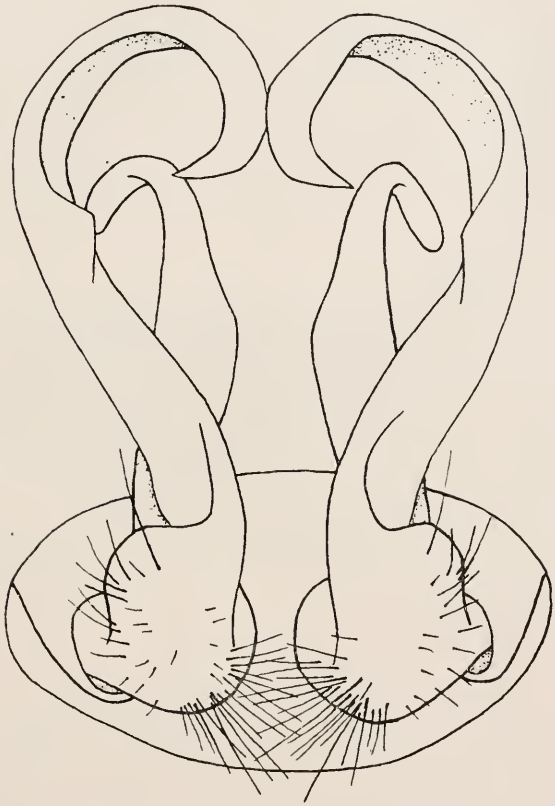


Fig. 65. *Cyrtaphe continuata*. Gonopods.

Sternum between the fifth legs normal as are the sterna between the fourth and fifth legs of the females.

Pterygiodesmus new genus

Type. *Pterygiodesmus strumosus* new species.

Diagnosis. The exact position of this genus in the classification system cannot be determined until males are known but the reduced

lateral carinae seem to associate it with *Ricodesmus* from Puerto Rico, although the pores do not open from a special callus as in that genus.

Description. Body of moderate size, the sides parallel to near the back end; dorsum smooth, glabrous, very strongly arched, with lateral carinae rising nearly opposite the middle of the body and scarcely projecting from it except on the first four segments where the carinae are of normal size and have a small tooth at the anterior corner; on other non-poriferous segments the carinae are reduced to faint ridges apparent only on the posterior half of the segments; poriferous carinae thicker and slightly more prominent; pores opening outward from the usual segments.

Head deeply grooved on the vertex; front hispid; antennae rather slender but quite short.

First segment about as wide as the head; semi-circular.

Segments 2 to 4 shorter than those that follow but with the lateral carinae thinner and extending much farther from the sides of the body as in most of the other Hispaniolan genera of the family. On ensuing segments the posterior corners are scarcely produced behind the posterior margin, even on the two segments preceding the last.

Last segment broad at base but narrowing abruptly to a produced tip exceeding the broad, thickly margined anal valves.

Legs short, not projecting far beyond the sides of the body; joint 3 nearly as long as the remaining joints together; sterna broad and with a few small, fine setae.

Pterygiodesmus strumosus new species

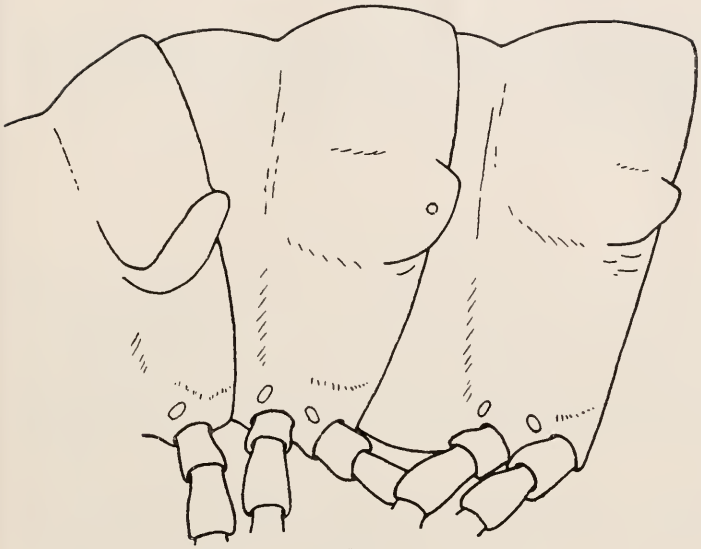
One female collected at La Vestite, 6000 to 7000 feet elevation, La Selle range, Sept. 16–23, 1934 by P. J. Darlington. Type in M. C. Z.

Description. Length 30 mm., width 4 mm. Segments light colored throughout except for a brownish band encircling the body and including the constriction between the anterior and posterior subsegments.

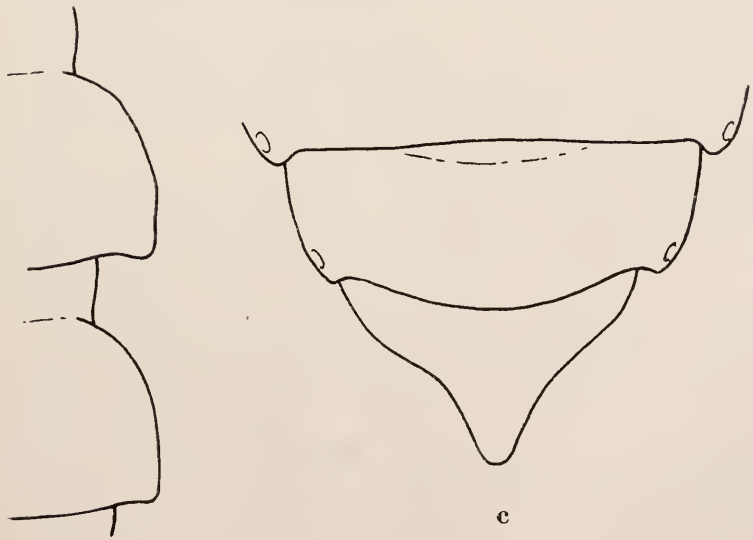
Head sparsely hispid on the frontal region, the surface elsewhere smooth and shining.

First segment with evenly rounded anterior margin bordered by a raised rim on the sides; posterior margin broadly emarginate at middle; posterior corners forming nearly right angles.

Segments 2 to 4 with front and outer margins of the lateral carinae bordered by a raised rim, a small tooth at the anterior corner of each carina. Surface below the carinae coarsely wrinkled but on the ensuing



a



c

b

Fig. 66. *Pterygiodesmus strumosus*. *a*, Lateral view of segments 4, 5 and 6; *b*, Dorsal view of lateral carinae of segments 5 and 6; *c*, Dorsal view of last two segments.

segments the sides are much less wrinkled. A lateral view of segments 4, 5 and 6 is shown in figure 66, *a*, and dorsal views of segments 5 and 6, and segments 19 and 20 are shown in figure 66, *b* and *c* respectively.

Last segment with the produced apex scarcely deflexed.

Family POLYDESMIDAE

This family contains many species in North Temperate regions, but few representatives are known from the Tropics, especially of the Western Hemisphere, only two being reported by Chamberlin from the West Indies, one of which came from Hispaniola. Accordingly it was with particular interest that additional species were found in Hispaniola. Three of these subsequently were made the types of separate genera, and two other species are herein described as the types of new genera.

Most of the Hispaniolan species thus far known are of very small size, and their active movements when disturbed make capture, without injury to them, no easy task. The genera are separated in the following key.

Key to the Hispaniolan genera of Polydesmidae

Body of moderate size, over 16 mm. long ..... *Trematodesmus* new

Body small to minute, never over 10 mm. long .....

Segments with many long, erect hairs scattered on the dorsum; segments 1 to 18 with two teeth or conic tubercles on each side of the dorsum near the carina and projecting beyond the posterior margin ..... *Dasyodontus* new

Segments with fewer setae and these arranged in definite series; dorsum lacking large conic tubercles near the carinae .....

Segments with strong, seta-bearing tubercles arranged in six or more transverse series; carinae with the caudal corners rounded ... *Mesethodesmus* Chamberlin

Segments without conspicuous tubercles; setae arranged in two or three transverse series; carinae with the caudal corners acute .....

Number of segments 20; pores subdorsal; living color pink or coral ... *Chilaphrodesmus* Loomis

Number of segments 18; pores dorsal; living color white .....

Dorsal setae strongly clavate; lateral margins of the carinae simple; first segment oval, without acute, produced, posterior corners
Agenodesmus Loomis

Dorsal setae slender; lateral margins of the carinae dentate; first segment semicircular, with acute posterior corners.....
Hexadesmus Loomis

Trematodesmus new genus

Type. *Trematodesmus setiger* new species.

Diagnosis. This is the largest West Indian member of the family and is without close relatives, but the position of the pores and the arrangement of the dorsal setae associate it, to a certain extent, with *Chilaphrodesmus.* The large setiferous dorsal tubercles rising from the densely pitted surface, and the strikingly dentate lateral carinae, distinguish the genus.

Description. Body moderately slender; dorsum slightly convex transversely with the lateral carinae ascending a little above it; dorsal surface with large, conic, coarsely setiferous tubercles, definitely arranged and rising from the densely pitted surface. Outer margin of the lateral carinae strongly toothed.

Head with clypeal region elevated above the front; antennae rather short, the outer joints finely pubescent, joints 5 and 6 with an oval or semi-circular sensory organ near the distal margin on the posterior side.

First segment narrower than the head and much narrower than the second segment, semi-circular in outline, with posterior corners produced backward and bearing a stout apical bristle; a row of 10 conic, setiferous tubercles along the anterior margin, and a sub-median row of four similar tubercles. (Fig. 67, *a.*)

Second segment with the anterior margin of the body wall, below the lateral carinae, produced forward and outward into a large triangular lobe against which the back side of the head rests.

Beginning with the second segment the lateral carinae have a non-setiferous tooth at the anterior corner which is followed by four larger teeth each terminating in a coarse bristle. Pores on the usual segments, borne dorso-laterally in front of the base of the posterior tooth of the carinae; immediately above the pore is a small setiferous tubercle not present on the other segments. The posterior margin of the segments has a prominent tooth adjacent to the base of the lateral

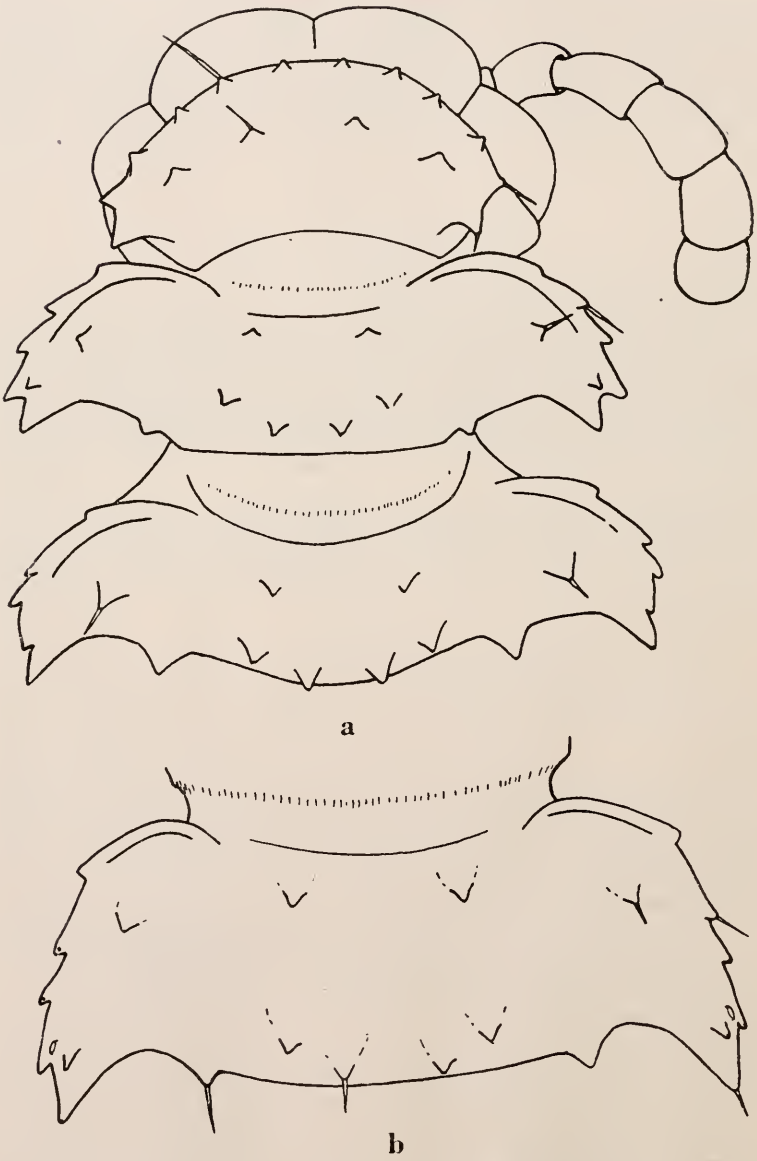


Fig. 67. *Trematodesmus setiger*. *a*, Dorsal view of head and first three segments; *b*, Dorsal view of segment 15.

carinae. Dorsum with two conic, setiferous tubercles in front and four others near the back margin; lateral carinae with a large setiferous tubercle centrally located. A characteristic segment is shown in figure 67, *b*. In addition to the large tubercles the dorsal surface is everywhere finely pitted.

Last segment sub-conic, ending in a slightly deflexed tip surpassing the valves; surface punctate and with about 15 or 16 small setiferous tubercles in three irregular rows, one crossing the middle, another at the posterior fourth, and one just preceding the apex.

Anal valves broad, convex, the margins very thin and scarcely elevated, meeting almost at the level of the surface of the valves.

Preanal scale large, broadly truncated behind.

Males not known.

Trematodesmus setiger new species

Two mature females and one with 19 segments collected between 3000 and 7800 feet elevation on Morne La Hotte, Oct. 16–17, 1934 by P. J. Darlington. Type and paratypes in M. C. Z.

Description. Length of the largest specimen 18 mm., width 3 mm. Color very dark brown, almost black.

Head with the raised clypeal region smooth and shining, remainder of the head densely punctate, with fine erect setae from the posterior part of the clypeal region to well above the antennae. Groove of the vertex deep.

Poriferous segments with the same number of lateral marginal teeth as the nonporiferous segments but the third setiferous tooth is depressed below the position it occupies on the nonporiferous segments and there is a dorso-lateral tubercle above the pore, not present on the other segments, except segment 2. The constriction encircling the segments just in front of the lateral carinae is deep, broad, less conspicuously pitted and more shining than the surface either side of it; the surface immediately in advance of the constriction is more coarsely pitted than the posterior subsegment.

In the female the ventral surface of the third segment is elevated behind the sternum and coxae of the second legs into a ridge which surpasses the sternum in height, the posterior face of the ridge with a long horizontal depression below the crest.

Other characters are given in the generic description.

Agenodesmus Loomis

Agenodesmus reticulatus Loomis

Agenodesmus reticulatus Loomis, Smiths. Misc. Coll., **89**, no. 14, pp. 38–41. 1934.

Haitian localities are Fond des Negre; between Petit Goave and Leogane; and Le Borgne.

This is the smallest milliped of the Western Hemisphere, the largest specimen seen measuring but two millimeters in length and a quarter of a millimeter in width. It is a rapid moving little creature, usually found among dead leaves in rather moist locations.

Hexadesmus Loomis

Hexadesmus lateridens Loomis

Hexadesmus lateridens Loomis, Bull. Mus. Comp. Zoöl., **75**, pp. 362–363, 1933.

An immature specimen of this species was collected at Petite Riviere de Artibonite. The type locality is in Cuba, and the species also has been found in the islands of St. Kitts and Carriacou.

Chilaphrodesmus Loomis

Chilaphrodesmus rubellus Loomis

Chilaphrodesmus rubellus Loomis, Smiths, Misc. Coll., **89**, no. 14, pp. 42–44, 1934.

The type locality is the summit of Morne Pilboreau. Specimens also were found within the Citadel, and between Kenscoff and Petionville, L.

Mesethodesmus Chamberlin

Mesethodesmus haitianus Chamberlin

Mesethodesmus haitianus Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 248, 1918.

Known only from the original collection at Furcy.

Dasyodontus new genus

Type *Dasyodontus hispaniolus* new species.

Diagnosis. This genus is unique in having 2 strong teeth arising from the posterior surface of the dorsum on each side and projecting beyond the hind margin from segments 1 to 18 inclusive. The long hairs of the dorsal surface, and the strongly toothed margin of the lateral carinae combine further to facilitate recognition of the genus.

Although the animal is of small size it has the full complement of 20 segments and the gonopods of the male show closer relationship to *Polydesmus* than to the group containing such genera as *Brachydesmus*, *Agenodesmus* and *Chilaphrodesmus*.

Description. Body tiny, slender, composed of head and 20 segments which have the surface shining and rather thickly invested with long, erect hairs, each rising from a swollen base or a minute tubercle difficult to distinguish. Anterior subsegments, ventral portions of the posterior subsegments, sterna, anal valves, and preanal scale densely impressed with large round pits. The general aspect is of a *Polydesmus* but the sculpturing is different.

Head exposed on the sides and in front of segment 1 from above; thickly beset with shorter hairs than those of the segments. Antennae widely separated, rather short and stout; joint 6 longest and thickest; joint 2 considerably shorter than 6 but next to it in length.

First segment slightly narrower than the head or the second segment, nearly semicircular in outline, strongly convex, definitely swollen on each side adjacent to the posterior angle; hairs along the front margin considerably longer than those of the disc.

Segments 1 to 18 inclusive with 2 setiferous conic teeth arising from the posterior part of the dorsum on each side near the posterior angle and projecting beyond the back margin, the teeth most conspicuous on segments 3 and 4. Lateral margins of segments 2 to 19 with distinct, setae-bearing teeth, the tooth at the posterior corner of each carina larger than the others and strongly produced backward; the setae on these teeth are longer and heavier than the hairs of the dorsum. Lateral carinae of segment 2 with 5 teeth, segments 3, 4 and 6 each with 3 teeth; segments 5 and 7 to 18 with 4 teeth. On segment 19 the lateral carinae are nearly obsolete, being represented by only the posterior tooth on each side.

Pores present on segments 5, 7, 9, 10, 12, 13, 15–19, opening from a slight cone on the dorsal surface near the edge of the keels.

Last segment ending in a deflexed, setiferous mucro, considerably exceeding the anal valves.

Gonopods resembling those of *Polydesmus* rather than of the smaller members of the family.

First male legs reduced in size but none of the other pregenital legs specially modified.

Sternum between the second females legs broad and with a transverse concave area occupying much of it, other legs and sterna not modified.

Dasyodontus hispaniolus new species

A mature male (type) and female and a young male collected at Le Borgne, March 26, 1930, by W. H. Jenkins and O. F. Cook. Type in U. S. N. M. Paratype in M. C. Z.

Length 4.5 mm., width 0.6 mm.

Color in alcohol light brown.

Head broader than segment 1, shining, and covered with moderately long hairs over its entire surface; median groove confined to the vertex; distance between the antennae greater than the length of the first and second joints combined; joint 6 longest and broadest, about equal in length to joints 4 and 5 together; joint 2 about two thirds as long as joint 6 (Fig. 68, *a*.)

First segment somewhat intermediate in shape between semicircular and oval, the posterior angles abruptly rounded; dorsal surface near each posterior angle definitely swollen above the hind margin and bearing 2 conic teeth, which project beyond the margin when the animal is viewed from above, the outer tooth largest; both with a short hair arising from the upper side between the base and the apex. Surface of the segment with many long, erect hairs rising from swollen bases or very tiny, indistinct tubercles, requiring high magnification to be seen; the series of hairs along the anterior margin more uniformly arranged than those behind, which are somewhat shorter. Segments 1 to 3 shown in figure 68, *b*.

Second segment but slightly wider than segment 1; keels produced forward in front, the outer margin of each longer than the margins of the 2 immediately succeeding segments and with 5 distinct, setiferous teeth increasing in size from front to back, with the posterior one especially prominent; setae much longer than the hairs of the dorsum. On each side near the posterior angle 2 strong, sharply conic, setiferous teeth project back from the dorsum beyond the posterior margin as on segment 1. Dorsum covered with hairs similar to those of the first segment; with a definite anterior row, a less definite posterior row, and between the two a number of more or less scattered hairs.

Third and fourth segments with the lateral margins much shorter than those of the second segment; each with 3 marginal teeth. The conic tubercles as on the foregoing segments but slightly larger; hairs as on segment 2.

Fifth segment with the lateral margins considerably longer than those of the 2 preceding segments, each with 4 marginal teeth; the dorsum as on the foregoing segments except that the dorsal tubercles are not quite as large.

Sixth segment with 3 teeth along the outer margin of the carinae. Ensuing segments with 4 teeth along the outer margin of the car-

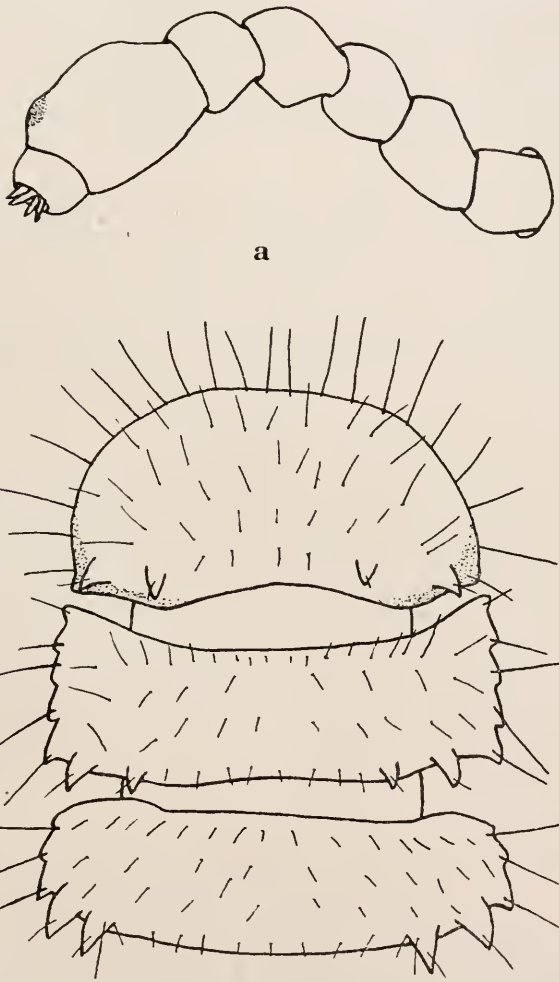


Fig. 68. *Dasyodontus hispaniolus*. *a*, Antenna; *b*, Segments 1, 2 and 3, dorsal view. The head was not drawn but is considerably wider than segment 1 and visible in front of it from above.

inae; the conic tubercles on the dorsum above the posterior margin quite uniform in size but considerably smaller than those of segments

3 and 4; median portion of the dorsum with a very faint transverse impression.

Penultimate segment with the carinae rudimentary, the lateral teeth represented by only the one at the posterior corner on each side; dorsum without the conic tubercles on each side above the back margin. Ventral surface with a series of hairs along the posterior margin, and in front of this a few scattered hairs at middle.

Anal valves with thin, raised margins; surface moderately convex, filled with large, round pits.

Preanal scale large, elliptic; the seta on each side arising from a large, prominent tubercle; surface pitted similarly to the valves.

Anterior subsegments descending abruptly at the posterior fourth to join the posterior subsegment; the surface filled with relatively large, round, rather shallow, highly polished pits, becoming smaller toward the front of the subsegment. Posterior subsegments below the carinae impressed with slightly larger pits than those on the anterior subsegments. Sterna also somewhat pitted and with a few setae; a broad, transverse depression also evident.

The gonopods, encumbered with dirt difficult to remove, are apparently definitely Polydesmid in type, each having a slightly enlarged, hairy basal portion, from the anterior part of which the slender terminal portion arises and projects forward over the sternum of the legs of the sixth segment; the tip of this portion is divided into two short prongs of which the outer one appears to be longest and curving toward the body.

Female with sternum of the second legs broader than the one on either side, distinctly convex, with a large, transversely oval concavity at the middle appearing to be somewhat spongy within and containing a few short setae. Sternum of the third legs very narrow, coxae almost touching. Ensuing sterna broad.

Family CHYTODESMIDAE

Key to the Hispaniolan genera of Chytodesmidae

First segment with posterior margin crenately lobed . . *Lobodesmus* new
First segment with posterior margin not lobed . . . . . .
Dorsum, including the carinae, very flat; carinae projecting from above the middle of the body, none of the margins with deep incisions . . . . . *Docodesmus* Cook

Dorsum moderately to strongly convex; carinae projecting from opposite or below the middle of the body, and with at least one margin deeply incised .....
Dorsum moderately convex; carinae narrow, projecting from opposite the middle of the body; the posterior margin of each carina with a single deep conspicuous incision ..... *Coccoelasma* new
Dorsum strongly convex; carinae wide, projecting from below the middle of the body; posterior margin of each carina with several deep incisions .....
Principal body segments with longitudinal rows of high, slender tubercles distinctly bent toward the rear; carinae with the margins definitely elevated, anterior and posterior margins incised, lateral margin entire ..... *Cyphotylus* new
Principal body segments with longitudinal rows of broad, low tubercles; margins of the carinae not elevated but all margins deeply incised ..... *Iomoides* Loomis

Docodesmus Cook

In describing *Cryptodesmus vincenti*, Pocock referred to the sternum of the eighth somite of the male being furnished in front with a pair of tubercles tipped with a brush of hairs, and a somewhat similar tubercle on each coxa of the anterior legs of this somite. These specializations apparently are of specific importance and are not present in any of the Hispaniolan species thus far known. In strictly generic characters these species agree with *vincenti*. The presence of repugnatorial pores in *vincenti* has been pointed out by Cook, and they are found in the Hispaniolan species, which may be separated by the following key.

Key to the Hispaniolan species of Docodesmus

Large animals, from 16 to 19 mm. long ..... *haitiensis* Chamberlin
Small animals, not exceeding 10 mm. in length .....
Color dark brown, almost black; dorsal sculpturing distinct; posterior subsegments with a raised rim extending across the anterior margin of the keels and the dorsum ..... *parrior* Chamberlin
Color light brown; dorsal sculpturing rather indistinct; posterior subsegments with a raised rim on the anterior margin of the keels but not present between them across the dorsum ..... *semiseptus* new

Docodesmus haitiensis Chamberlin

Docodesmus haitiensis Chamberlin, Bull. Mus. Comp. Zoöl., **62**, no. 5, p. 216, 1918.

The species has been collected in the following localities. Diquini, (type locality); Ennery; Petionville; Furcy; Jacmel; (W. M. Mann); Kenscoff; Trouin; between Leogane and Petit Goave; Carrefour, Riviere Froid; Christophe's Citadel; C. & L. Morne La Hotte and Etang La Chaux, Oct. 1934, P. J. Darlington.

A female collected on Morne Pilboreau above Ennery has the ventral crest of the third segment shorter than in the southern specimens and the crest on each side behind it is higher and longer. A male from the same locality appears to be no different from the southern forms and a series collected at the Citadel is in agreement with them.

This species is rather light brown and reaches a length of 19 mm. and a width of 4.5 mm. In addition to the features described by Chamberlin the areas along the front margin of segment 1 are distinctly longer than broad; the posterior margin is straight across the median third, the lateral third on each side directed forward, not covering the anterior margin of segment 2 near the angles.

Lateral expansions of the segments reaching far from the sides of the body; elevated areas on the convex portion of the dorsum rather low and not especially distinct, and with small granules in addition to the larger ones, particularly on the second transverse series of areas; sulci along the posterior margin rather short, the intervening spaces nearly square; anterior margin of the segments, except the first and last, with a thin raised rim extending from one anterior angle to the other.

Penultimate segment with the posterior angles large and strongly produced backward.

Third segment of the females beneath with a long, very high, thin, backwardly rolled crest immediately behind the second pair of legs and with a short, low crest each side behind the ends of the large crest.

Coxae of the second legs of the female produced backward into broad flat, rounded lobes below the level of the crest of segment 3.

Docodesmus parvior Chamberlin

Plate 3, Fig. 3

Docodesmus parvior Chamberlin, Bull. Mus. Comp. Zoöl., **62**, no. 5, p. 218, 1918.

The type locality is Furcy, (W. M. Mann). Collected at Petionville; Diquini; Carrefour; Riviere Froid; between Leogane and Petit Goave; Fond des Negre. C. & L. Kenscoff, 1934, L.

This species is dark brown, almost dull black, and the largest specimens do not exceed 10 mm. in length and 2 mm. in breadth. Males more slender than the females.

The areas along the front margin of the first segment are broader than long, the margin itself being proportionally narrower than in *D. haitiensis;* posterior margin on each side of the median third only slightly produced forward, narrowly covering the anterior margin of the second segment on each side near the angles.

Lateral expansions of the segments short, not extending far from the sides of the body; elevated areas on the median portion of the dorsum higher and more distinct than in *D. haitiensis* and with no secondary granules in addition to the large granules; sulci along the posterior margin long, the intervening spaces longer than broad; anterior margin of the segments, except the first and last, with a fine raised rim extending across the body from an anterior angle to the other.

Penultimate segment with the posterior angles small and frequently not much more conspicuous than the intervening marginal projections.

Ventral crest of the third segment of the females longer than in *D. haitiensis* but not as high, and there are no small secondary crests behind it.

Docodesmus semiseptus new species

A male (type) and female collected on Morne Pilboreau, above Ennery, July 8, 1927. C. & L. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. This species is distinguished from *D. parvior* by the lighter color; less distinct sculpturing of the dorsum; the interrupted raised rim of the anterior margin of the segments and the more strongly produced posterior angles of the carinae.

Description. Color light brown; length 8 mm., width 1.7 mm.

First segment narrowed in the male the angles not reaching to the anterior angles of the second segment; surface somewhat uneven but without definite raised areas or granules on the median portion; of the 12 marginal areas the median 4 are quite narrow as compared with the next 3 on each side, the center one of which is twice as wide as any pair of the 4 median areas in the male, but in the female the median 4 are not quite as narrow.

Segments with the granules nearly obsolete, the large dorsal areas disposed as in the other species but very indefinite in outline, especially the outer one on each side in front, which has no median granule evident, thus there are 2 granules on the anterior part and 4 on the posterior part of each segment; longitudinal sulci of the posterior margin behind the 2 inner areas extremely short and inconspicuous and separated by 2 or 3 times their length; lateral margins of the segments straighter and somewhat longer than in *D. parvior*, the posterior cor-

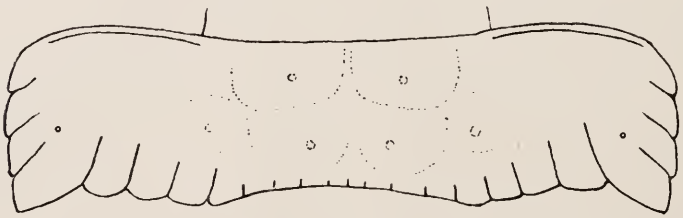


Fig. 69. *Docodesmus semiseptus*. Segment 12 of male, dorsal view.

ners being more produced caudad, as is especially noticeable from the middle of the body to the penultimate segment inclusive; posterior corners of the penultimate segment very long and slender; segments, except the first and last, with a fine raised anterior marginal rim on the lateral expansions or keels but none across the middle of the body; posterior subsegments descend rather gradually to the anterior subsegments. Segment 12 is shown in figure 69.

Sterna slightly broader and flatter than in *D. parvior*.

Gonopods *in situ* not noticeably different from those of *D. parvior*.

Ventral crest of the third segment of the female present as a thin, raised rim as long as in *D. parvior* but not approaching the same height.

Lobodesmus new genus

Type. *Lobodesmus granosus* new species.

Diagnosis. Relationship with *Tridesmus* is indicated by the trilobed poriferous carinae, but the more slender body, smaller first segment scalloped along the posterior margin, and the six-lobed posterior margin of the other segments are characters peculiar to this genus.

Description. Body about six times as long as broad, narrowing gradually at the ends; lateral carinae level with the dorsum; dorsal surface with distinct tubercles and dense granulations; legs extending somewhat beyond the sides of the body.

Head with the front bearing many fine erect hairs to above the base of the antennae; vertex not grooved at middle; antennae long and slender.

First segment elliptical, short, considerably narrower than segment 2; anterior margin only slightly expanded over the head and with ten distinct lobes; posterior margin almost evenly rounded from side to side and with eight lobes, of which the four median ones are largest; surface granular and with two transverse rows of large tubercles.

Segments 2 to 4 increasing in width; lateral carinae with three lobes of which the last is the largest and somewhat produced backward; segment 5 with only two lateral lobes but thereafter the poriferous carinae are trilobed to segment 16 where four lobes are very faintly apparent; posterior margin of segments 2 to 19 with six conspicuous lobes or crenations; surface finely granular and with two transverse rows of large tubercles in front of the scalloped posterior margin, the four median scallops of which each contain a smaller tubercle.

Segments 17, 18 and 19 gradually narrowing to the small last segment which scarcely surpasses the tips of the carinae of segment 19.

Gonopods simple, consisting of a swollen basal joint from which a long erect terminal joint rises.

Lobodesmus granosus new species

A single male collected between 3000 and 7800 feet elevation on Morne La Hotte, Oct. 16–17, 1934 by P. J. Darlington. Type in M. C. Z.

Description. Length 9 mm., with 1.5 mm. Color pink in alcohol.

Head with the vertex evenly convex, finely and densely granular and without a median groove. Antennae long and slender; joint 5 the longest; joints 5 and 6 with a sensory cluster of short papillae near the apex on the outer side; joints 6 and 7 subequal in length but the latter much more slender. (Fig. 70, *a*.)

First segment as described for the genus and as shown in figure 70, *b*.

Ensuing segments as described for the genus and as shown in

figure 70, *c*. for segment 10. The outer margin of the lateral carinae has many very short and very inconspicuous erect hairs. Segments 16, 17 and 18 with the poriferous lobe very strongly produced back-

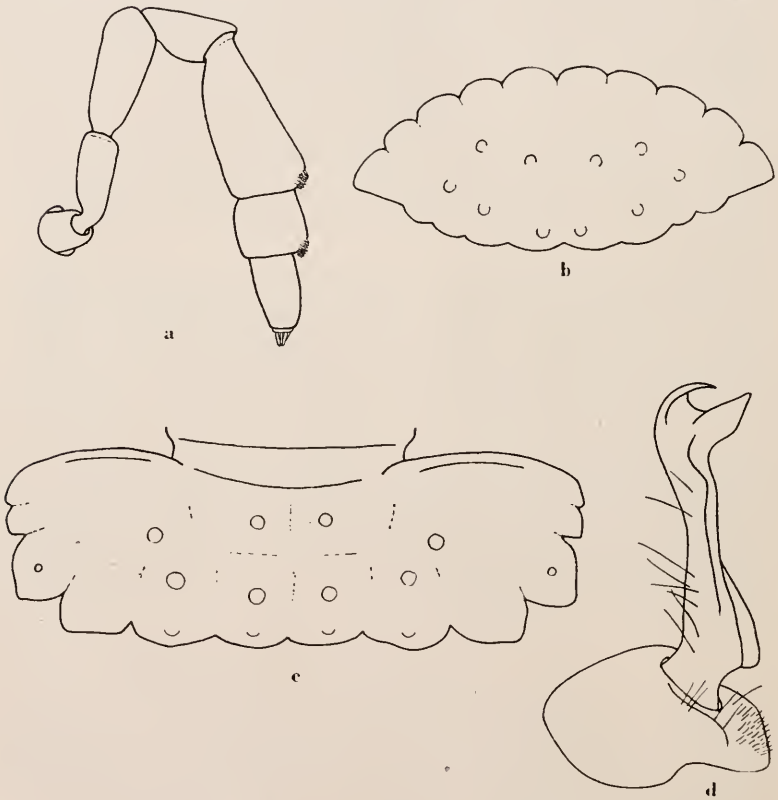


Fig. 70. *Lobodesmus granosus*. *a*, Antenna; *b*, Segment 1, dorsal view; *c*, Segment 10, dorsal view; *d*, Left gonopod.

ward and sharply angled at apex; segment 19 has the poriferous lobes strongly produced, narrow, and rounded behind.

Gonopods as shown in figure 70, *d*.

Legs of moderate length but somewhat exceeding the sides of the body because the lateral carinae do not project as far as in closely related genera; pregenital legs without special modifications.

Coccoelasma new genus

Type. *Coccoelasma incisura* new species.

Diagnosis. This genus is definitely associated with *Docodesmus* as attested by the proportions of the body and antennae; the location of the pores; the squamate areas of the dorsum; and the structure of the male organs. However, in *Coccoelasma* the dorsum is more convex and is covered with fine granules; the first segment is narrower than the second and has a very narrow anterior margin; the ensuing segments have 3 instead of 2 areas in the longitudinal rows; and the posterior margin of each keel has a very deep incision. *Stictodesmus* Cook, from Colombia, is a very closely related genus having the first segment narrower than the second, and a deep notch in the posterior margin of the keels, but the dorsal surface apparently has no granules or tubercles and the rectangular areas are very indistinct; the keels of the fifth segment have 4 lateral lobes; and the keels of the penultimate segment are scarcely produced backward.

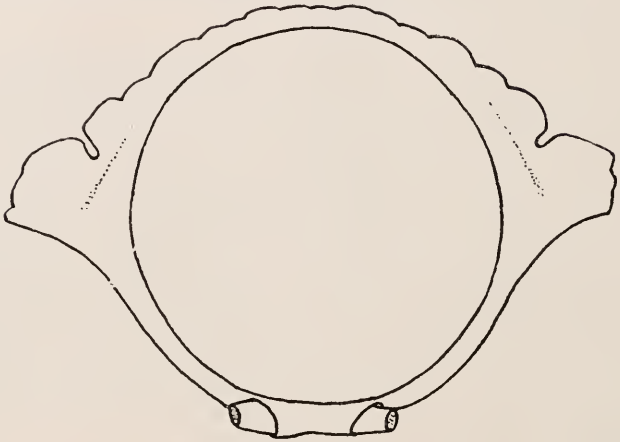
Description. Body small, moderately slender, nearly 7 times as long as broad; dorsum rather convex (Fig. 71, *a*), the entire surface densely granular, median sulcus faint but evident; lateral keels scarcely depressed, slanting slightly downward, not quite horizontal, projecting from the body a distance less than half the diameter of the body cavity.

Head strongly convex; surface above the level of the antennae extremely finely and densely granular; median furrow present; anterior surface smooth and shining. Antennae long, strongly clavate; joints 1 and 4 subequal in length, shorter than either joint 2 or 3, of which joint 3 is the longest, two-thirds as long as joint 5 which is fully twice as wide; joint 6 not quite as long as joint 2; joint 7 half as long as joint 6.

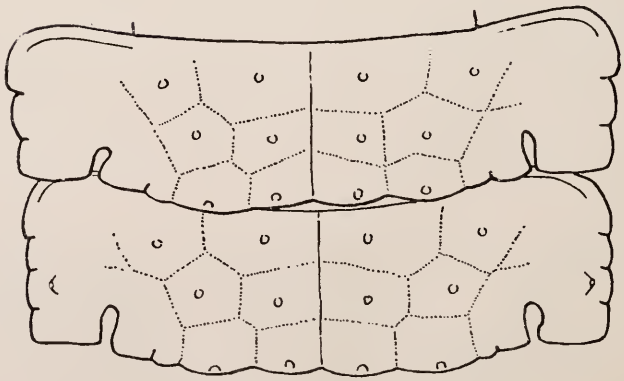
First segment narrower than segment 2, barely covering the head from directly above, nearly flat, subelliptic in outline; front margin broadly rounded, with 10 rather indistinct scallops, the expanded portion very narrow, not definitely defined, horizontal; lateral angles obtuse; posterior margin more transverse than the front margin. Surface very finely and densely granular, with two transverse rows of small, rounded, indistinct tubercles, 4 tubercles in the anterior row and 6 in the posterior row.

Second segment definitely longer at the middle than either of the next 2 segments, the anterior margin curving strongly forward on each side from the median line to the front corner of the keel; lateral

margin of the keel over half again as long as the margin of the keels on either segment 3 or 4.



a



b

Fig. 71. *Coccoelasma incisura*. *a*, Segment 10, posterior view; *b*, Segments 14 and 15, dorsal view.

All nonporiferous segments from the second to the fourteenth inclusive, with the keels 3-lobed, the sulcus which terminates in the

sinus between each of the lobes short and indistinct. Segment 5 with the keels 3-lobed, but on all the other pore-bearing segments the keels are 4-lobed. Pores present on segments 5, 7, 9, 10, 12, 13, 15 to 19, but not plainly visible, opening from the top of a tiny tubercle near the middle of the third area of the keel and not far from the lateral margin.

In the posterior margin of each keel near its base, on all segments except the first and last, there is a very deep incision which has a constricted neck; the lobe of the margin just mesad of the incision has its outer corner somewhat turned up; between this lobe and the outer rectangular area of the posterior series on the dorsum a smaller lobe is usually visible, although set off by only a shallow indentation. All segments except the first with the anterior margin continuous from the outer corner of one keel to the other, not lobed, but on the anterior segments the margin is raised into a thin but distinct rim somewhat irregular at the apex, this rim soon disappears after the middle of the body is passed.

Segments with the surface of the dorsum, exclusive of the keels, faintly set off by impressed lines into transverse, rectangular areas arranged in 3 transverse series, 4 areas in each series and each area with a small, low, rounded, seta-bearing tubercle in its center, the remaining surface of each area and the surface of the keels is very densely covered with fine granules. Segments 14 and 15 are shown in figure 71, *b*.

Penultimate segment with the keels produced caudad behind the posterior margin for a considerable distance, the intervening margin straight across and with 6 prominent rounded scallops; similar scallops are present on the segments in front of the penultimate but are decreasingly evident.

Last segment with 2 large conic, somewhat depressed tubercles on the dorsal surface; posterior margin with 6 small, setiferous lobes; the papillate cone arising just under the apical margin and slightly exceeding it.

Anal valves strongly convex, the margins high and thick.

Preanal scale subtriangular, with 2 seta-bearing tubercles.

Sterna as broad as the first joint of a leg, median depression conspicuous.

Gonopods similar in general structure to those of *Docodesmus*.

Males with the sternum between the pair of legs just behind the gonopods somewhat broader than the sterna that follow.

Females with the entire ventral surface of the third segment pro-

duced to the level of the first joint of the legs following it; the anterior margin raised into a low, thin rim or crest.

Coccoelasma incisura new species

Plate 3, Fig. 4

Many specimens, including the male type, collected among dead leaves on the Ile de Cabret, near Bayeux, May 12, and July 13, 1927. L. Other specimens were collected the same year on Morne Brigand, near Bayeux; and on Morne Pilboreau, above Ennery. Type in U. S. N. M. Paratype in M. C. Z.

Length of the largest specimen 6 mm., width .9 mm.

Living color brown with a tinge of pink, posterior end of the body somewhat lighter colored than the anterior end.

Segments with the outer tubercles on each side less evident than the inner rows, the tubercles of the middle and last row increasingly closer to the middle line of the segment and smaller than those of the first series, especially on all but the first few segments.

Other characters appear in the generic description.

Cyphotylus new genus

Type. *Cyphotylus prolatus* new species.

Diagnosis. Most closely related to *Coccoelasma* but somewhat more convex, the keels more depressed and extending further from the sides of the body; first segment as broad as the second and with a very broad, reflexed anterior margin; ensuing segments with 4 longitudinal rows of high tubercles bent toward the rear; front and back margin of each keel with several deep incisions; posterior margin of the penultimate segment produced backward between the produced keels, almost hiding the last segment from above.

Description. Body with the dorsum notably more convex than in *Coccoelasma,* the lateral keels definitely depressed, projecting from opposite or slightly below the middle of the body and extending further from the sides of the body. Dorsum with 4 parallel, longitudinal rows of high, slender, very conspicuous tubercles bent toward the rear; remainder of the surface more or less incrusted with dirt but where the surface is visible it is shining and does not appear to be granular; median line present but not very evident.

Head with the vertex finely granular; median sulcus present; antennae much as in *Coccoclasma* but a little longer and stouter.

First segment as wide as the second, strongly convex, with the anterior border strongly rounded, very broad, smooth and shining, held horizontally but with the outer margin flexed upward; border with 10 elongate areas forming very indefinite scallops on the front margin; surface of the disc possibly somewhat granular beneath the incrustation but with 2 conspicuous transverse rows of high, slender tubercles, 4 tubercles in the anterior row and 6 in the posterior one; posterior margin with a fine, raised rim extending from one lateral angle to the other.

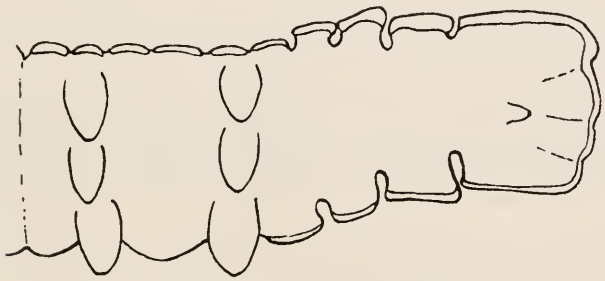


Fig. 72. *Cyphotylus prolatus.* Right half of segment 10, dorsal view.

Second segment with the lateral margin of each keel slightly longer than that on either of the 2 succeeding keels.

Nonporiferous segments from the second to the fourteenth, and also the poriferous fifth segment, with the lateral margin of each keel 3-lobed; other poriferous segments with the keels 4-lobed. Pore formula normal. The pore is borne on a small, slender, inconspicuous tubercle some distance from the lateral margin near the mesial end of the sulcus between the inner lobes of the lateral margin of the keel.

Surface of all segments from the second to the penultimate inclusive with 4 parallel, longitudinal rows of tubercles, 3 tubercles in each row; the tubercles slender, higher than their diameter, and strongly bent caudad; those on the posterior segments slightly larger and conspicuously longer than on the other segments. Although impossible to observe with accuracy, because of the accumulation of dirt, the surface elsewhere appears to be shining and faintly raised into transverse rectangular areas, perhaps similar in arrangement to those in *Coccoclasma;* the surface of the lateral keels seems also to be smooth

and shining except when a pore tubercle is present; keels with the margins narrowly but very definitely elevated, especially the anterior margin; inner half of the anterior margin of each keel with 3 deeply separated, apically elevated lobes; inner half of the posterior margin with 2 lobes separated from themselves and the rest of the margin by deep, bottle-necked incisions, the outer lobe longest; outer half of the anterior and posterior margin of each keel continuous; anterior margin of the dorsum of each segment with a number of small, raised scallops; posterior margin of the dorsum on each side of the middle with a large scallop on each side of the last tubercle in the dorsal rows.

The right half of segment 10 is shown in figure 72.

Penultimate segment with the posterior corner of each keel strongly produced backward; posterior margin between the keels very much produced backward from the base of the keels, the median portion of the margin exceeding the produced corners of the keels and hiding all but the apex of the last segment. Last tubercle in each of the longitudinal rows surpassing the posterior margin for a considerable distance.

Last segment with the dorsum not exposed from above but with 2 small tubercles visible beneath the overhanging margin of the preceding segment; posterior margin with 2 small, setiferous teeth on each side of the papillate apical cone.

Anal valves moderately convex, with high, rather thick margins.

Preanal scale with the posterior margin rather broadly rounded at the middle but emarginate on either side.

Sterna much narrower than in *Coccoelasma*, not as wide as the basal joint of one of the legs.

Male organs not fully developed as the type has but 19 segments.

Cyphotylus prolatus new species

A single male with but 19 segments was collected on Morne Brigand, near Bayeux, July 16, 1927, L., with many specimens of *Coccoelasma incisura*. Type in U. S. N. M.

The specimen is broken into several pieces and accurate measurement is impossible, however, it appears to have been of the size and proportions of the species with which it was collected and at the time it was collected it was not sufficiently different in color to be recognized as another species.

Many of the characters included in the generic description are doubtless of specific value but as only a single species is thus far known no attempt has been made to separate these characters.

Iomoides Loomis

As their names imply, the species may be recognized by whether or not the dorsum is hispid or glabrous.

Iomoides hispidus Loomis

Iomoides hispidus Loomis, Smiths, Misc. Coll., **89**, no. 14, pp. 51–52, 1934.

The type locality is the lower slope of Morne Brigand, facing Bayeux. Other specimens were collected to Le Borgne, C.

Iomoides glabra Loomis

Iomoides glabra Loomis, Smiths, Misc. Coll., **89**, no. 14, p. 53, 1934.

The Citadel is the type locality. Two males collected beneath fallen leaves in a coffee plantation between Kenscoff and Petionville, July 2, 1934, L.

Family EOROMIDAE new[1]

A new milliped, with such unusual characters that its relationships must remain in doubt, was found on the Southern Peninsula of Haiti in 1926. In view of the divergence from other forms now recognized in the system of classification it seems necessary to describe this creature as the type of a new family, the *Eoromidae*, named with reference to the markedly ascending position of the enormously developed lateral carinae.

Description. Body small and rather loose-jointed, about 5 times as long as broad; composed of 20 segments; dorsum of the segments rather narrow and flat, giving rise to the very large carinae which are elevated at an angle of about 45 degrees.

Head large, subglobular, not completely hidden by the first segment; antennae of moderate length, widely separated at base.

First segment deeply concave; the anterior margin greatly elevated, much wider than the posterior margin and distinctly lobed, the two lateral lobes greatly exceeding the four median lobes.

[1] The descriptions and remarks pertaining to this milliped were prepared jointly by O. F. Cook and H. F. Loomis.

Ensuing segments with the dorsum smooth, lacking a median longitudinal furrow, narrow and nearly straight across; the carinae subcylindrical or subclavate, terminating in a very large oblique knob, tuberculate on the surface; the basal portion of the carinae of mature specimens usually is sheathed in a thick crust of spongy exudation or other extraneous material which makes the carinae appear much stouter than they actually are. Margins of the segments and carinae, from the second to the penultimate segment, entire, without distinct lobes or incisions.

Repugnatorial pores borne in a slight depression on the outer side of the terminal knob of the carinae, each pore surrounded by a raised rim. Pore formula normal, except that the series terminates on segment 18.

Penultimate segment with the carinae relatively small, flattened, thin, produced caudad at the sides, but not elevated, and without repugnatorial pores.

Last segment with the basal portion exposed dorsally between the carinae of the penultimate segment, the projecting apical portion broadly triangular, abruptly narrowed near the tip.

Anal valves moderately convex, the margins broad and slightly elevated.

Preanal scale truncate at apex, with a seta on each side.

Legs reaching a little beyond the sides of the body, rather slender, the last joint longest. No secondary sexual specializations noted in the legs of either sex.

Sterna moderately broad, exceeding the diameter of the first joint of the leg.

Gonopods with the basal joint on each side large, bulbous; the long, simple, apical joint exposed and carried forward horizontally.

The relationships of the family are difficult to determine, as *Eoromus* is a most anomalous milliped. The structure of the first segment and of the male gonopods, and the laterally borne repugnatorial pores, may point to relationship with such groups as the Stylodesmidae, Hercodesmidae, and Stiodesmidae, although the analogies with these families may not extend beyond the fact that the pores open from definitely formed tubercles on the margins of the lateral carinae. The carinae of other groups are thin, with two or more lateral lobes, and the projection of the carinae is outward and downward, instead of upward. The large dorsal processes of *Stylodesmus* may be considered as a parallel evolution, on account of their position, but do not bear the repugnatorial pores, which are on lateral carinae in the usual

position, much lower on the body. The dorsum in the Hercodesmidae and Stiodesmidae is convex and tuberculate, whereas in *Eoromus* it is nearly straight across, and the surface is smooth, instead of sculptured.

Close relatives of *Eoromus* may yet be found, but it is possible that this milliped is the only extant member of an aberrant line reaching back into geologic times, as seems to be the case with other extremely specialized forms in this order. The family Hylomidae was established for a Chinese genus having erect, several-branched carinae, a condition not approached in any other living milliped, as far as known, but finding certain analogies among the fossil forms. Another outstanding example is the Pandirodesmidae, based on *Pandirodesmus disparipes* Silvestri, from British Guiana, which seems worthy of full family rank, although Silvestri considered it only as a subfamily under the Trachelodesmidae, stating that conservatism made him unwilling to increase the number of recognized families. The tubiform spiracles of *Pandirodesmus*, the exceedingly long anterior pair of legs, and the much shorter posterior legs, with the different insertion of the legs on the segments, are specializations not indicated in any other milliped. Whether a family or a subfamily should be recognized, will depend upon the existence of an intermediate series to connect with *Trachelodesmus*. With *Eoromus* also it is possible that the discovery of intermediate forms may show an alliance with some of the groups already known.

Eoromus new genus

Type. *Eoromus aberrans* new species.

Characterized by the unique armature of the body: the massive uplifted carinae: to which the name alludes. Other genera have large carinae as flattened expansions of the body segments or as slender processes, while in the present type the carinae not only project farther than the body cylinder is wide, but are robust and thickened toward the end, so that the form as well as the proportions of the carinae are different from those of other groups.

A peculiar spongy incrustation encases the basal portion of the carinae and occurs with such regularity on all of the mid-body segments as to give the appearance of a structural feature, though the material is readily removable, like a surface accumulation or exudate. A small median area, circular or annular, also is covered with such material, as shown in Plate 3, figure 5. Other millipeds have hispid

surfaces that hold particles of soil, but such accumulations are not so definitely formed or so regularly repeated as those on the segments of *Eoromus*.

Eoromus aberrans new species

Plate 3, Fig. 5 & 6

A mature male (type) and female, and four males with 19 segments were collected at the base of a limestone cliff, south of the divide near Trouin, on the road to Jacmel, April 11, 1926, C.

Type in the U. S. N. M. Paratype in M. C. Z.

Description. Length of the male 8 mm., width 1.6 mm.; female 9 mm. long, 1.8 mm. wide.

Head partially hidden by the first segment, sub-globular, not at all flattened in front; vertex with a fine median furrow, the surface smooth but usually with a thin removable coating; the surface elsewhere smooth and slightly shining. Labrum with three minute median teeth. Antennae broadly separated, moderately long, strongly clavate and not abruptly geniculate; joint 5 longest and thickest, joints 3 and 2 decreasing in order, joints 4 and 6 subequal, joints 1 and 7 shortest, subequal. (Fig. 73, *a*). The head and anterior segments are seen in two views in figure 73, *b* and *c*.

First segment considerably narrower than the ensuing segments, subquadrate; anterior and posterior margins transversely parallel, the anterior much broader and almost vertically elevated above the head, rather thin, divided into six lobes or scallops; the four inner lobes small and subequal, the two lateral lobes more than twice as wide as the median lobes and projecting obliquely upward, like the carinae of the following segments. Lateral margins strongly converging backward, each with a small distinct tooth in front of the middle. Surface of the segment smooth and shining when the layer of incrustation is removed, and with a large central concavity, deepest in front.

Ensuing segments with the dorsum much narrower than the body cavity (Fig. 73, *d*); the dorsum of each segment strongly convex longitudinally but nearly straight transversely; surface smooth and shining throughout but usually with a removable coating thinly dispersed, except at the middle, where each segment shows a broad, rounded elevation somewhat spongy in texture. Lateral carinae nearly as broad as the body cavity, arising from the side of the dorsum and projecting obliquely upward at an angle of 45 degrees; the carinae of the anterior segments are directed slightly forward while those of the last three or

four segments are directed increasingly backward; the basal portion of each carina constricted, cylindric, smooth, except for a tooth or

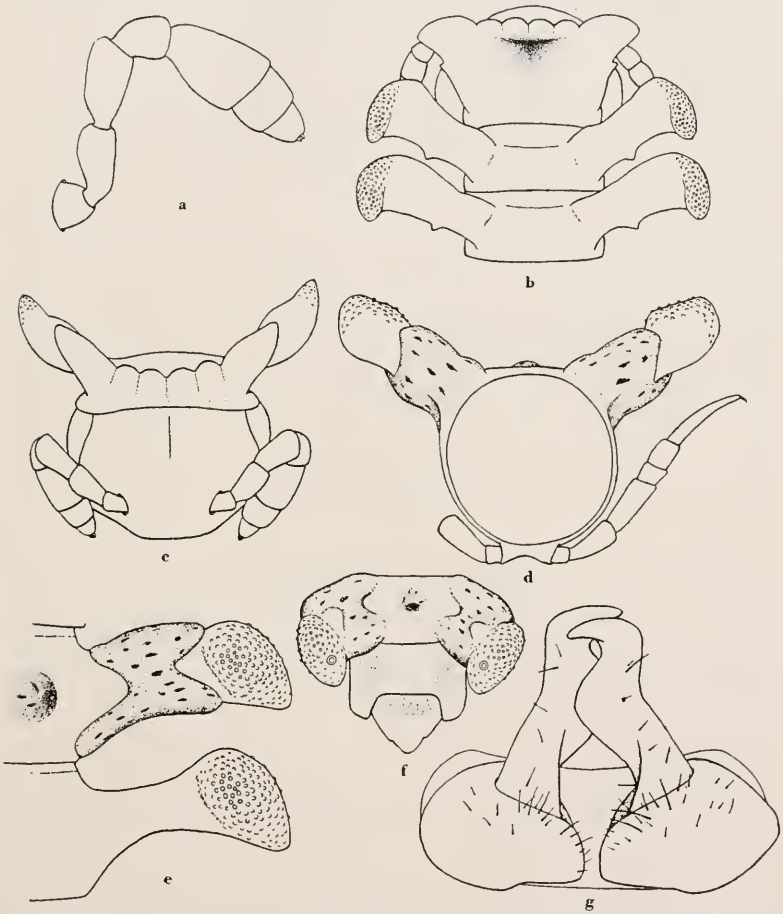


Fig. 73. *Eoromus aberrans*. *a*, Antenna; *b*, Head and first three segments of 19-segmented male, dorsal view; *c*, Head and first two segments, front view; *d*, Segment 13, posterior view; *e*, Lateral carinae of segments 11 and 12, dorsal view. The incrustation of dirt removed from the carina and dorsum of segment 12; *f*, Segments 18, 19 and 20, dorsal view; *g*, Gonopods.

notch behind, near the middle, reduced or lacking on the posterior segments. The basal portion of each carina is encased in a definitely

formed, thick, sheathing crust or accumulation (Fig. 73, *e*), easily removed when dry and of a brittle, spongiform texture, the surface of the crust rather smooth and even, though showing occasional cavities which may be accidental. Though at first considered as a part of the animal, the crust was found on careful examination to separate readily from the body walls, and in the 19-segmented forms the crust material was slight and variable in amount, the most recently molted specimen having a smaller accumulation than others which had molted somewhat earlier. In the specimens with 19 segments the basal portions of the lateral carinae have a few short hairs which undoubtedly would aid in the accumulation of extraneous material in forming the sheath, but hairs are not visible on the dorsum of these specimens. Hairs may be present on the carinae of mature specimens and may break off when the incrustation is removed. The incrustation is brown while the projecting terminal portion of the carina is white, thickened and knob-like, with the surface densely tuberculate; the pore is surrounded by a broad raised rim, located in a shallow depression of the lateral surface, near the posterior corner of the carina, becoming more dorsal in position on the last few poriferous segments (Fig. 73, *f*). The pores are found on segments 5, 7, 9, 10, 12, 13, 15 to 18.

Segments 2 and 3 with the outer ends of the carinae much less inflated and tuberculate than on the following segments.

Penultimate segment with the lateral carinae thin and very small, as compared with the large, elevated carinae of segment 18, almost horizontal and directed nearly straight back, greatly exceeding the posterior margin of the dorsum, the apical margin of each carina obliquely truncate (Fig. 73, *f*).

Last segment with the posterior half exceeding the carinae of the preceding segment, the 4-papillate apex scarcely deflexed, with a small scallop on each side (Fig. 73, *f*). Rim enclosing the anal valves and preanal scale nearly circular.

Anal valves moderately convex, the margins broad and slightly raised.

Preanal scale subtriangular, the apex broadly and squarely truncate, with a seta at each angle.

Legs rather slender, reaching somewhat beyond the carinae; outer joint longest; third joint next in length, followed by the second joint, joints 1 and 4 subequal, exceeded in length by joint 5. None of the legs of either sex with specialized sexual characters.

Sterna somewhat broader than the length of the basal joint of the leg; deeply furrowed lengthwise and crosswise.

Gonopods with the basal joint large, subhemispherical, opening on the inner side, the outer joint projecting forward from the opening, quite simple, stout, thickest near the middle, and bowed mesad; the apex bent sharply mesad and somewhat produced (Fig. 73, *g*).

Sternum of the seventh male legs considerably broader than that of the sixth legs, and with a broad median concavity, closed in front but open behind for the accommodation of the tips of the gonopods.

Females with the ventral margin of the third segment raised into a thin, slightly revolute crest, immediately behind the second pair of legs.

The specimens were found in humus adjacent to a small clearing, at the base of a cliff that faced to the north. A protracted search was made for additional material, and in subsequent visits many adjacent places were examined, but not other specimens were found. The general appearance of the living animal, when partially coiled, so that the projecting carinae are separated, suggests a bizarre insect larva, rather than a milliped.

Family STIODESMIDAE

The Hispaniolan genera are separated in the ensuing key.

Key to the Hispaniolan genera of Stiodesmidae

Repugnatorial pores in a nearly continuous series, on segments 5, 7–18, omitted from segment 6; dorsum of principal segments with 4 nearly touching, transverse rows of distinct tubercles, those of the anterior row the largest and projecting forward over the anterior subsegment, those of the posterior row small ..... *Homodesmus* Chamberlin

Repugnatorial pores in a more interrupted series, absent from segments 6, 8, 11 and 14 at least; dorsum with the principal tubercles more widely separated and arranged in longitudinal rows .....

Pores on only 5 segments; 5, 7, 9, 12 and 15 ..... *Penteporus* new

Pores on 7 segments, at least, including segments 10 and 12 .....

Pores present on 7 segments, 5, 7, 9, 10, 12, 13, and 15 .....
Psochodesmus Pocock

Pores present on 8 segments, 5, 7, 9, 10, 12, 13, 15 and 16 .....

Carinae of segments 3 to 19 inclusive, bilobed .. *Lophodesmus* Pocock

Carinae of some of segments 3 to 19 with 3 or even 4 distinct lobes ..
Cynedesmus Cook

Homodesmus Chamberlin

Homodesmus parvus Chamberlin

Homodesmus parvus Chamberlin, Bull, Mus. Comp. Zoöl. **62**, no. 5, p. 223, 1918. Type locality Manneville. Collected at Thor, near Port au Prince; Ennery; Source Matelas; and between Leogane and Petit Goave in 1927. C. & L.

The following features were noted in addition to those mentioned in the original description of the species.

Antennae with the sixth joint considerably longer than any other joint. Keels of second segment definitely four lobed.

All segments except the first and the last 3 with 4 distinct transverse rows of tubercles; the first row largest and strongly projecting forward beyond the anterior margin high over the surface of the anterior subsegment; the following 2 rows with the tubercles slightly decreasing in size; last row along the posterior margin, the tubercles low and transverse, in contrast to the very convex tubercles of the other rows, and not projecting beyond the margin. Last 3 segments lacking the fourth row of tubercles, the third row extending along the posterior margin. Posterior ventral margin of segments elevated on either side of the middle.

Last segment with a low, hollow, truncated cone on the ventral side between the apical margin and the anal valves, containing 4 setiferous papillae.

Anal valves nearly flat, the margins not elevated; surface finely and very densely granular.

Legs moderately separated by elevated sternal processes, the anterior process of each segment slightly wider and higher than the other process.

Penteporus new genus

Type. *Penteporus crenellatus* new species.

Diagnosis. In general appearance suggesting *Cynedesmus* or related genera, but immediately distinguished by having only five poriferous segments: 5, 7, 9, 12, and 15. The Mexican genus *Deeaporodesmus*, and the Cuban *Heteropente*, have but five poriferous segments which are respectively as follows: 5, 7, 10, 13, and 15; and 5, 7, 10, 13, and 16.

Description. Body very strongly arched, the lateral carinae rather short and extending obliquely downward and outward, and equalled but not exceeded by the tips of the legs.

Head rather strongly convex, very densely and irregularly granular above the upper limits of the antennal sockets; antennae of moderate length; joints 1 and 4 subequal, exceeded in length by joints 2 and 3, of which the latter is longest; joint 5 as long as the two preceding joints together and much wider than either; joint 6 about two-thirds as long as 5 and not quite twice as long as 7, which is longer than broad.

First segment with the anterior margin scarcely flaring, divided into 12 lobes of which the two outer ones on each side are narrower than the inner ones, which are subequal in width. Surface densely and coarsely granular, with an anterior row of four large round tubercles, and a posterior row of six somewhat larger tubercles.

Ensuing segments densely granular, with 4 longitudinal rows of large round tubercles, 3 tubercles in each row. Lobes of the lateral keels and of the posterior margin, to the first row of large tubercles, separated by deep, more or less lageniform incisions. Posterior margin between the rows of large tubercles with broad lobes projecting slightly upward and backward. Pores borne on rather long cylindrical processes almost completely occupying the posterior lobe of the keels of segments 5, 7, 9, 12 and 15, and projecting obliquely caudo-ectad.

Last segment with 6 marginal lobes; surface with a low tubercle on each side just in front of the apex.

Anal valves smooth, slightly convex, the margins decidedly thickened but very little elevated. Preanal scale triangular, smooth.

Legs very narrowly separated by the sterna.

Third segment of the females with a long, low, vertical crest immediately behind the second pair of legs.

Penteporus crenellatus new species

The female type, another female and 2 immature specimens collected beneath coffee bushes at Fond des Negre, June 28, 1927, C. & L. Type in U. S. N. M. Paratype in M. C. Z.

Living color of the posterior subsegments light brown above, lighter below, becoming nearly white near the feet; anterior subsegments, anal valves, preanal scale, legs and antennae white; head with the anterior portion white to between the antennae, above which the surface is light brown.

First segment with the outer marginal lobe on each side very narrow, the adjoining lobe twice as wide but narrower than the

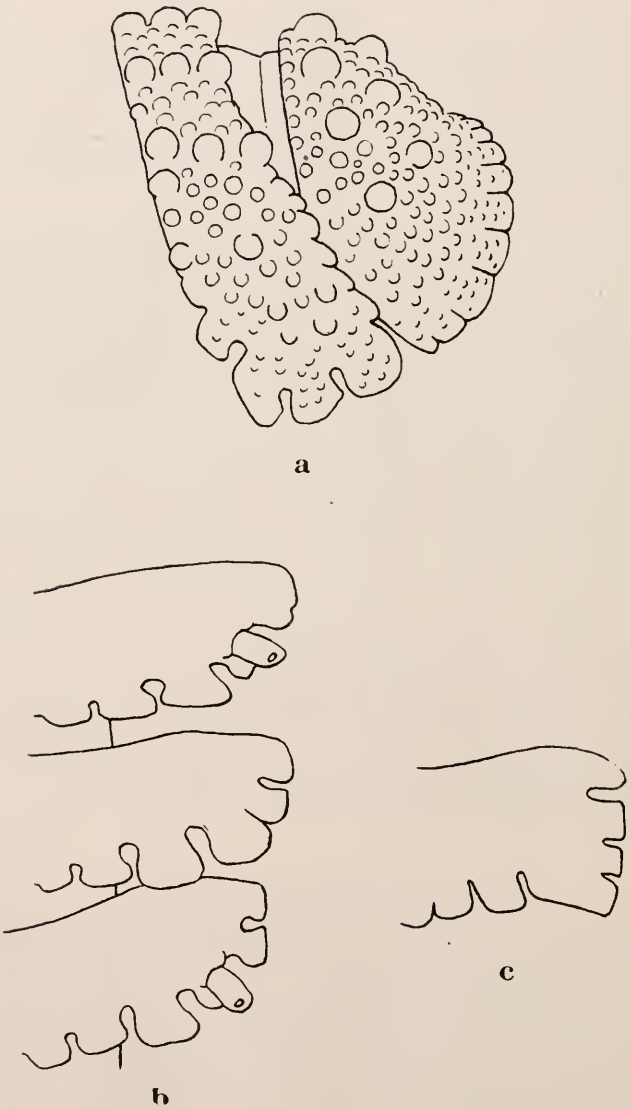


Fig. 74. *Penteporus crenellatus.* *a*, Segments 1 and 2, oblique lateral view; *b*, Lateral carinae of segments 5, 6 and 7, oblique lateral view; *c*, Lateral carina of segment 17 in outline.

ensuing ones, which are of uniform width; all the lobes short and scarcely at all produced forward, the surface finely granular. Surface of the disc conspicuously and quite irregularly granular-tubercular, with a transverse anterior row of 4 large rounded tubercles and a posterior row of 6 larger ones (Fig. 74, *a*).

Ensuing segments to the penultimate with coarse, highly elevated granules densely scattered over the surface and with 4 longitudinal rows of large, high, rounded tubercles, 3 tubercules in each row; between the middle tubercle of the outer row and the keel on the nonporiferous segments there is a single tubercle nearly as large as those of the dorsal rows. On the posterior segments the tubercles are larger and higher than on the other segments, the posterior one in each row extends high above the margin without being definitely produced backward.

Except for segment 5, segments 2 to 16 inclusive have the lateral margins of the keels divided into 3 lobes by deep, more or less flask-shaped incisions; on the poriferous segments other than the fifth the last lobe is almost entirely occupied or replaced by the cylindrical pore process (Fig. 74, *b*). On segment 5 there is a single large lobe in front of the one bearing the pore, instead of 2 smaller lobes. Segments 17 to 19 have 4 lateral lobes (Fig. 74, *c*). The last segment has 6 marginal lobes, the outer one on each side the largest. All lobes with the surface finely granular in contrast to the coarsely granular dorsum. From segment 2 to segment 19 inclusive all segments have 3 large, deeply separated lobes on the posterior margin on each side between the last lobe of the keel and the end of the lower row of large dorsal tubercles; between the outer and inner row of tubercles there is a broad, slightly raised and protruding lobe and 2 similar lobes between the inner rows of tubercles.

Coxae of the second legs with rather prominent inner corners contiguous mesially.

In the paratype female the incisions between the lateral and posterior lobes are so filled with dirt as to be almost completely obliterated, causing the margins to appear undulated rather than very definitely lobed.

Psochodesmus Cook

Xerodesmus Chamberlin, Proc. Calif. Acad. Sci., **12**, p. 403, 1923.
Tidopterus Chamberlin, Zoölogica, New York Zoöl. Soc., **3**, no. 21, p. 420, 1923.
Dominicodesmus Chamberlin, Proc. Biol. Soc. Washington, **36**, p. 189, 1923.

Psochodesmus granulofrons (Chamberlin)

Treseolobus granulofrons Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 221, 1918.
Dominicodesmus geophilus Chamberlin, Proc. Biol. Soc. Washington, **36**, p. 189, 1923.

The specimens described as *T. granulofrons* came from Jacmel. *D. geophilus* was described from a specimen found at Washington, D. C. in soil about a palm plant from Puerto Plata, Dominican Republic. The present collection contains specimens from Thor, near Port-au-Prince; Ennery; Morne Pilboreau; near Plaisance; and Petite Riviere de Artibonite. The species seems to be well distributed through the West Indies, having been found in five other islands.

Cynedesmus Cook

Cynedesmus varilobatus new species

Plate 3, Fig. 7.

Numerous specimens, including the male type, were collected beneath leaves on the ground in a coffee planting near the road going down the hill east of Petit Goave from Leogane, June 28, 1927. C. & L. A female with 19 segments collected at Diquini, June 26, 1927, also appears to belong to this species. Type in U. S. N. M. Paratype in M. C. Z.

Description. Largest specimen 7.2 mm. long and 1.3 mm. wide.

Head with the vertex dark brown to the upper limits of the antennal sockets between and below which it is white; antennae also white.

First segment and the posterior division of the subsequent segments blackish-brown above, somewhat lighter below; last segment a little lighter on the dorsum than are the other segments; poriferous tubercles white; anterior subsegments white throughout, as are the anal valves, preanal scale, legs and sterna.

Head with the dark portion densely granular-tuberculate. Antennae with joint 3 longer than joint 2 or 4; joint 5 broader than the others and twice as long as joint 4 or 6; joint 6 slightly longer than joint 4.

First segment with the anterior margin divided into 10 equal lobes. Surface densely, finely granular, with a transverse anterior row of 4 large granules or tubercles and a posterior row of 6 similar tubercles, of which the inner 2 are the largest.

Succeeding segments densely granular and with 4 longitudinal rows of large tubercles, 3 tubercles in each row; on several segments in front of the last one the posterior tubercle in each row projects beyond

the posterior margin; granules between the 2 inner rows of tubercles numerous and not arranged in longitudinal series. Nonporiferous segments from segment 2 to segment 14 inclusive with the lateral margin of the keels tri-lobed, the keels of segments 17, 18 and 19 with 4 lobes; last segment with 3 lobes on each side of the middle of the posterior margin. Segment 5 with a single lobe in front of the poriferous tubercle; all the other pore-bearing segments with 2 lobes in front of the tubercles.

Fig. 75. *Cynedesmus varilobatus.* Gonopod, lateral view.

Anal valves nearly flat, the margins slightly raised.

Gonopods shown in lateral view in figure 75.

Males with the coxa of each of the second legs with a rounded swelling on the inner corner. Sternum between the sixth legs narrow, normal; sternum between the seventh legs very broad and depressed far below the level of the preceding sternum to accommodate the anterior part of the gonopods.

Females with a very long, thin, raised rim on the ventral side of segment 3 immediately behind the second pair of legs.

Lophodesmus Pocock

Lophodesmus caraibianus (Chamberlin)

Plate 3, Fig. 8

Treseolobus caraibianus Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 220–1, 1918.

Cynedesmus caraibianus (Chamberlin), Proc. U. S. Nat. Mus., **60** p. 59, 1922.

Specimens were collected in the following places: Ennery, Thor, Source Matelas, and Leogane in 1925 and 1927. C. & L.

The following characters were not given in the original description.

Living color brownish with a distinct tinge of pink; explanate anterior margin of segment 1 and the lateral keels of the segments lighter; surface above and on the under side of the keels peppered with very tiny black points; anterior subsegments and the surface of the posterior subsegments in the region of the legs, the anal valves, preanal scale, antennae, and legs white.

Dorsum very strongly arched; keels greatly depressed and produced outward further than in *Cynedesmus*.

Head greatly flattened in front; surface above the antennae brown, rather coarsely granular, distinctly elevated, and limited on each side by a definite ridge which extends upward from just above the antennal socket; a median sulcus, which widens conspicuously in front, crosses the area. Surface between and below the antennae smooth and shining, white. Antennae very short and stout, received in deep recesses which extend upward and outward; joints 1, 2, 3, 4, and 6 subequal in length; joint 5 wider than any of the others and nearly twice as long, but still scarcely longer than broad.

Anal valves long and narrow; both the outer and inner margins elevated, the intervening surface distinctly concave.

In general form the gonopods somewhat resemble those of *L. laminatus* as shown in Pocock's drawings, the hollow basal joint enclosing the extremely crassate apical joint.

Sterna between all legs narrow; the sternum between the fourth legs of the male produced in front into a high, thin lobe with the sides slowly converging toward the narrowly transverse apex, the lobe curving slightly forward from the base to apex. *Lophodesmus laminatus* Pocock is described as having a raised process on the sternum of the fifth segment but it is not shown in the drawings.

Females with the ventral portion of the third segment raised into a long, moderately thin crest behind the second pair of legs.

The lobation of the lateral keels, the form of the gonopods and the presence of a process on the sternum between the fourth legs plainly places this species in the same series as the Central American species Pocock included under the East Indian *Lophodesmus*. Hence this is a member of one of the few genera common to Central America and Hispaniola. The remarkably strong tuberculation of segment 1 and the presence of 4 rows of dorsal tubercles distinguish this species from those described by Pocock.

Family HERCODESMIDAE

Two genera constitute this predominantly African family, not only in Hispaniola, but elsewhere in the Western Hemisphere. The first genus, *Styraxodesmus*, is distinguished by having only four poriferous segments, 5, 10, 13 and 16, and the tubercles of the first segment are not noticeably larger than those of the ensuing segments. *Dilophops* may be recognized by the presence of pores on segments, 5, 7, 9, 12, 13, 15 and 16, and the tubercles of segment 1 are very much larger than those of the segments that follow.

Styraxodesmus Chamberlin

These animals usually have an incrustation of dirt which obliterates most of the dorsal sculpturing, only the large tubercles showing through to advantage. At first the incrustation might be mistaken for part of the animal, but with care it may be scratched off with a needle.

The gonopods, as observed in *S. ater* new species, have the basal joints transverse-hemispherical, opening from the mesial face and capable of enclosing the small terminal joints.

Styraxodesmus furcatus Chamberlin

Styraxodesmus furcatus Chamberlin, Bull. Mus. Comp. Zoöl., **62**, No. 5, p. 222, 1918.

Type locality Jacmel.

Dr. Nathan Banks, of the Museum of Comparative Zoölogy at Cambridge, Mass., kindly examined the type of this species and wrote me as follows: "There are but two tubercles in the dorsal row, one in front and one near the hind edge (of each segment) but the lateral

rows have three tubercles and are crowded together or almost crowded together and the rows a little irregular."

I have seen no specimens.

Styraxodesmus ater new species

Plate 3, Fig. 9

Two males, one the type, and 3 females collected on the Ile de Cabrit, near Bayeux, June 13, 1927. L. Other males collected at Diquini, near Port au Prince; Cabaret between Port au Prince and La Arcahaie; and at Ennery, 1927, C. & L. · Between Leogane and Petit Goave, May 21, 1925. C. Type in U. S. N. M. Paratype in M. C. Z.

Diagnosis. This species differs from *S. furcatus* in the darker color; in having each of the four crests of segment 2 to segment 19 inclusive with only 2 tubercles.

Description. Size near *S. furcatus*, between 4 and 5 mm. long.

Head black to below the base of the antennae below which it is yellowish-white; antennae yellowish-white throughout. First segment black. Ensuing segments with the anterior subsegments yellowish-white above and below; the posterior subsegments black above and below, even to the base of the legs, the extremely narrow sterna also black. Anal valves, preanal scale and all joints of the legs yellowish-white.

Antennae with the fifth joint wider and fully twice as long as either the fourth or the sixth joint.

First segment as in *S. furcatus*. Other segments with 4 rows of dorsal tubercles but only 2 tubercles in these rows on each segment; inner row of tubercles on the posterior segments forming prominent crests and projecting backward on segments 18 and 19, the crests of segment 19 projecting backward nearly as far as the apex of the last segment; between the base of the keel and the outer row of tubercles on each segment a small round tubercle is usually present.

Last segment truncate or slightly retuse, with 2 distinct tubercles on each side.

Sterna very narrow, scarcely separating the legs; the sternum between the legs following the gonopods no wider than the other sterna.

Dilophops Loomis

Dilophops bullatus Loomis

Dilophops bullatus Loomis, Smiths. Misc. Coll., **89**, no. 14, pp. 59–62, 1934.

The type locality is Bayeux, but specimens also have been collected on Morne Pilboreau. The writer found a single specimen in the island of St. Kitts, in 1932.

INDEX

Achromoporus, 112
  coloratus, 112, 113, 115, 117, 119
  enneryensis, 115, 117, 118
  furcipes, 117, 118, 119
  robustus, 118
Agenodesmus, 156, 157
  reticulatus, 156
Alcimobolus, 56
  angustipes, 56, 57
Amphelictogon, 119
  manni, 119
Ancyrotricha, 6
Anocheta, 39
Aplopododesmus, 128, 139
  longipes, 139, 140

Beatadesmus, 128, 139
  utowani, 128
Brachydesmus, 157

Cambalidae, 35
Caraibodesmus, 133
  insignus, 133
  sallei, 136
Chelodesmidae, 110
Chilaphrodesmus, 153, 156, 157
  rubellus, 156
Chilognatha, 8
Chondrotropis, 120
  niger, 120, 121, 123, 124, 125
  pictus, 123, 126
  venustus, 126
Chytodesmidae, 160
Coccoelasma, 167, 170, 171, 172
  incisura, 167, 170, 172
Colobognatha, 11
Cryptodesmus vincenti, 161
Cubobolus, 53
  cinchonanus, 53
  consutus, 53
  rarior, 53
Cubocricus, 55, 56
  haitensis, 56
  suprenans, 67

Cyclodesmidae, 79
Cyclodesmus, 4, 79
  angustipes, 81, 85, 86
  crassartus, 81, 83, 84
  enneryensis, 87, 92, 98, 100
  falcarius, 98
  globulus, 90
  haitianus, 86, 100, 102
  incisus, 88
  insulanus, 92, 93, 95, 97
  montanus, 92, 95, 97, 98, 99
  nudatus, 83, 85, 93
  obesus, 81, 82, 83, 85
  porcellanus, 88
  rubellus, 95, 97
  setosus, 101
Cynedesmus, 180, 184, 186
  caraibianus, 186
  varilobatus, 184
Cyphotylus, 170
  prolatus, 170, 172
Cyrtaphe, 139, 142
  alternata, 142, 143, 145, 147, 148
  continuata, 142, 147
  lobipes, 145

Dasyodontus, 156
  hispaniolus, 156, 158
Decaporodesmus, 180
Dilophops, 187, 188
  bullatus, 188
Diplocheta, 31
Diplopoda, 6
Docodesmus, 161, 167, 169
  haitiensis, 162, 163
  parvior, 162, 163, 164
  semiseptus, 163
Dominicodesmus, 183
  geophilus, 184

Ellipodesmus, 111
  simplex, 111
Eoromidae, 4, 173

Eoromus, 174, 175
aberrans, 175, 176
Epinannolene, 31
convexus, 32
haitiensis, 31
ornata, 32
virgata, 32, 34
Epinannolenidae, 31, 35

Glomeridesmidae, 9
Glomeridesmus, 9
concolor, 9, 11
jenkinsi, 10
marmoreus, 11

Hercodesmidae, 174, 175, 187
Heteropente, 180
Hexadesmus, 156
lateridens, 156
Homodesmus, 180
parvus, 180
Hylomidae, 175

Iomoides, 173
glabra, 173
hispidus, 173

Julus beauvoisi, 59
haitensis, 56, 61
indus, 59

Leiocricus, 50, 53
diversipes, 50, 51
Leptodesmus sallei, 136
Limacomorpha, 9
Lobodesmus, 164
granosus, 164, 165
Lophocyclus, 79, 80, 102
laxatus, 102, 105, 106, 110
munitus, 105, 106, 108
passus, 103, 106, 108
pumilus, 108
Lophodesmus, 186, 187
caraibianus, 186
laminatus, 186

Lophoproctus, 6
aequatus, 7
comans, 7
niveus, 6, 7

Merocheta, 77
Mesethodesmus, 156
haitianus, 156
Microspirobolus, 4, 41
concinnus, 45
erythrotermus, 43
esulcatus, 41, 45
furcianus, 48
lineatus, 42, 43, 45, 47, 48
sigillatus, 50
Monocheta, 15

Nesobolus, 53, 58
beauvoisi, 59
domingensis, 61
indus, 59
maltzani, 61

Odontopeltis sallei, 136
Orthomorpha, 110
coarctata, 110
Orthoporus, 35
caelatus, 37
haitiensis, 36, 37
indus, 59
sculpturatus, 37, 38
triquetrus, 37

Pandirodesmidae, 175
Pandirodesmus, 175
disparipes, 175
Penteporus, 180
crenellatus, 180, 181
Pogonodesmus, 128, 137
pullus, 137, 138
Polydesmidae, 152
Polydesmus, 157
coarctata, 110
sallei, 133, 136
Polyxenidae, 6

Polyzoniidae, 11, 14
Prostemmiulus, 4, 15
  abditus, 17, 28, 29, 30
  affinis, 28
  clarus, 17, 21, 22, 28, 29
  clavipes, 26
  cognatus, 25, 26, 27
  heterops, 28, 29
  interruptus, 24
  quadristriatus, 17, 20, 21, 22, 24, 25, 26
  subulatus, 17, 20, 22, 25, 26
  venustus, 16
Pselaphognatha, 6
Psochodesmus, 183
  granulofrons, 184
Pterygiodesmus, 149
  strumosus, 149, 150

Quisquicia, 128
  engonata, 132
  insignis, 133, 134, 135, 136
  rubens, 135
  sallei, 136
  scitula, 128, 130, 132

Rhinocricus, 4, 53, 55, 58, 61
  albolatus, 71
  aposematus, 67
  cinctus, 72
  curtior, 63, 64
  domingensis, 61
  furcianus, 72, 74, 75
  lethifer, 67
  maltzani, 61
  mediator, 63, 66
  monilicornis, 62
  nigrescens, 71, 72, 75
  ramulus, 76
  rarior, 53
  rixi, 67
  scobinellus, 63
  smithi, 67
Ricodesmus, 150

Siphonocybe, 11, 12
  alba, 13
  harti, 13
Siphonophora, 11, 12
  gracilior, 12
  manni, 12
  proxima, 12
Siphonophoridae, 11
Siphonotus, 14
  purpureus, 14
  virescens, 14
Spirobolidae, 39, 59
Spirobolus dominicae, 50
  goesi, 50
  heilprini, 62
  lumbricinus, 50
  monilicornis, 62
  sancta-luciae, 50
Spirostreptidae, 31, 35, 59
Spirostreptus indus, 59
Stemmiulidae, 15
Stictodesmus, 167
Stiodesmidae, 174, 179
Strongylosma coarctatum, 110
  poeyi, 110
Strongylosomidae, 110
Stylodesmidae, 174
Stylodesmus, 174
Styraxodesmus, 187
  ater, 187, 188
  furcatus, 187, 188

Tidopterus, 183
Trachelodesmidae, 175
Trachelodesmus, 175
Trematodesmus, 153
  setiger, 153, 155
Treseolobus caraibianus, 186
  granulofrons, 184
Tridesmus, 164
Trigoniulus, 50
  lumbricinus, 50

Xerodesmus, 183
Zephroniodesmus, 9

EXPLANATION OF PLATES

PLATE 1

PLATE 1

Fig. 1. *Prostemmiulus cognatus*, female, dorsal view. X 4.4.
Fig. 2. *Rhinocricus lethifer*, male, ventral view. X 0.9.
Fig. 3. *Rhinocricus lethifer*, female, dorsal view. X 0.9.
Fig. 4. *Quisquicia scitula*, female, dorsal view. X 4.4.
Fig. 5. *Cyrtaphe alternata*, head and first seven segments of male, ventral view. X4.

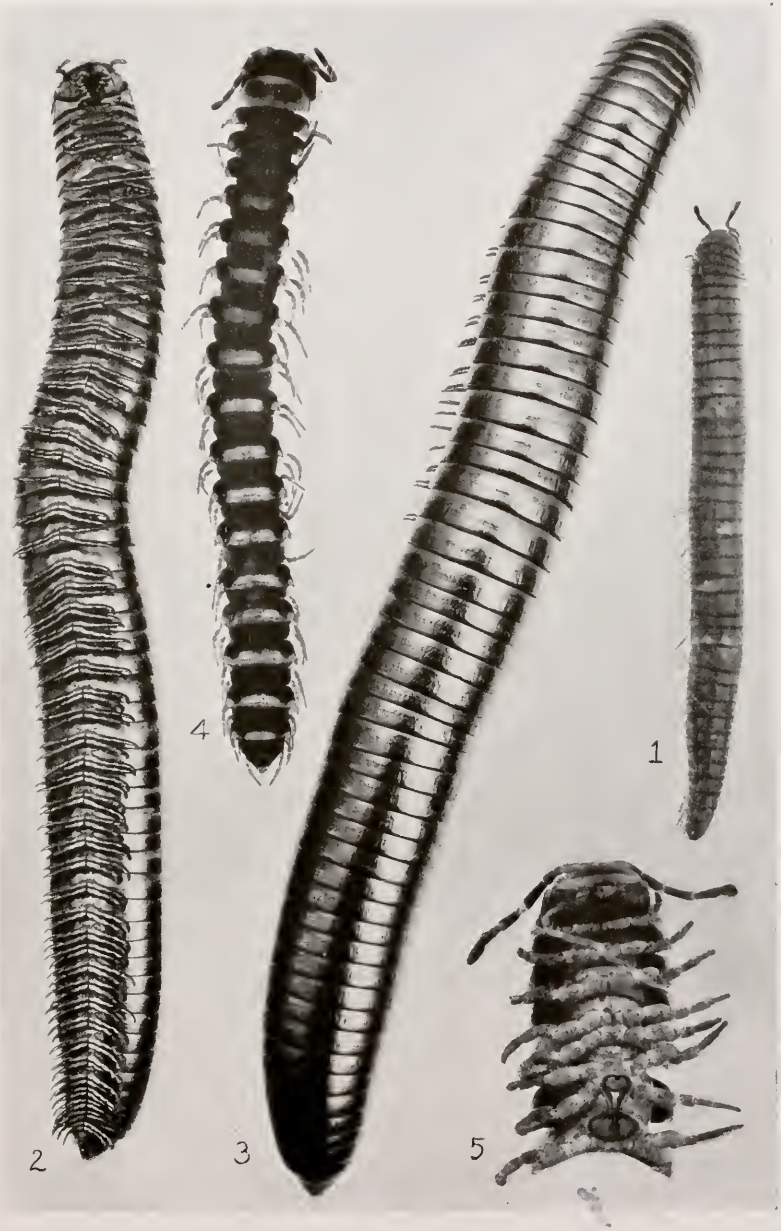

1
2
3
4
5

PLATE 2

PLATE 2

Fig. 1. *Cyrtaphe alternata*, male, dorsal view. X 4.
Fig. 2. *Chondrotropis pictus*, male, dorsal view. X 4.
Fig. 3. *Chondrotropis venustus*, female, dorsal view. X 4.

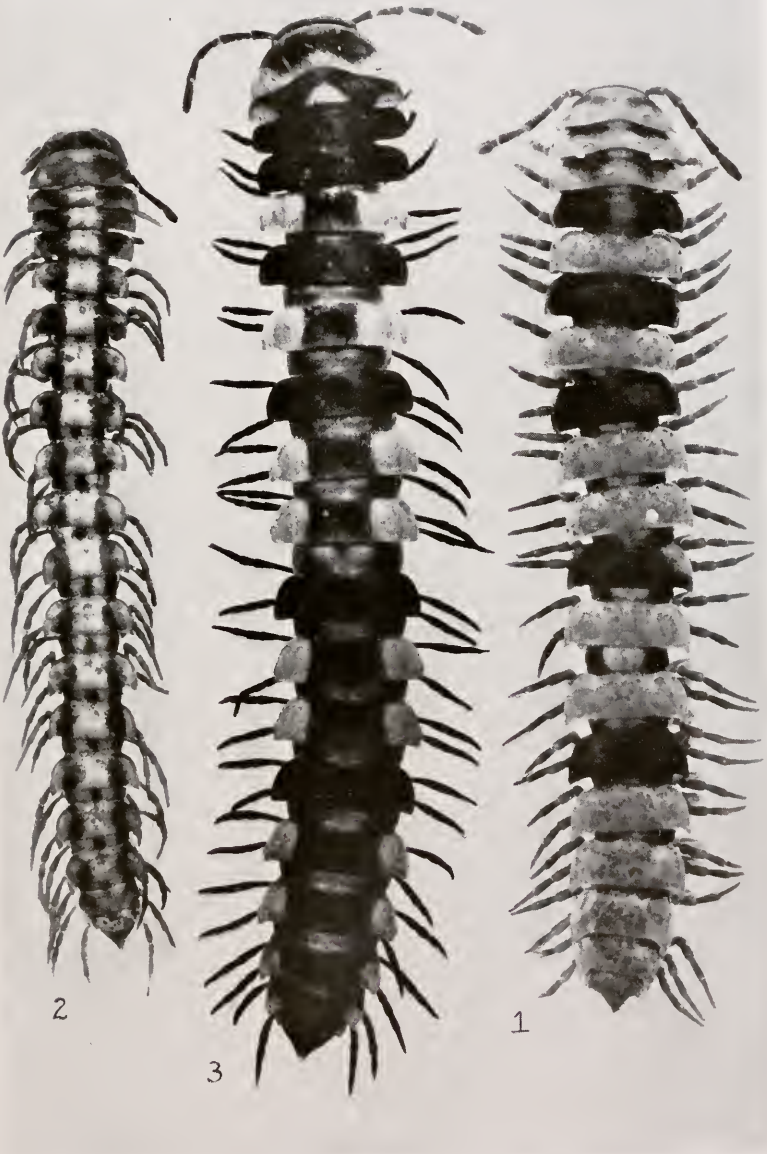

2
3
1

PLATE 3

PLATE 3

Fig. 1. *Cyclodesmus incisus*, male, ventral view. X 11.6.
Fig. 2. *Cyclodesmus incisus*, female, lateral view. X 11.6.
Fig. 3. *Docodesmus parvior*, female, dorsal view. X 8.9.
Fig. 4. *Coccoelasma incisura*, female, dorsal view. X 11.6.
Fig. 5. *Eoromus aberrans*, male, dorsal view. X 8.9.
Fig. 6. *Eoromus aberrans*, female, oblique lateral view. X 8.9.
Fig. 7. *Cynedesmus varilobatus*, female, dorsal view. X 11.6.
Fig. 8. *Lophodesmus caraibianus*, female, dorsal view. X 11.6.
Fig. 9. *Styraxodesmus ater*, female, dorsal view. X 11.6.

1
2
3
4
5
6
7
8
9

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
VOL. LXXX, No. 2

ANTS FROM HISPANIOLA AND MONA ISLAND

BY WILLIAM MORTON WHEELER

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
SEPTEMBER, 1936

No. 2.—*Ants from Hispaniola and Mona Island*

By William Morton Wheeler

The descriptions and records of ants in the following paper are based on four small collections. Two of these were made in the Haitian Republic by Mr. W. J. Eyerdam during the summer of 1927 and by Dr. P. J. Darlington during the autumn of 1934; the other two in the Dominican Republic by Mr. F. E. Watson in 1915 and on Mona Island by Dr. F. E. Lutz of the American Museum of Natural History in 1914. The material collected by Dr. Darlington is of unusual interest because it adds some 13 species, subspecies and varieties to the list of known ants from Haiti and strengthens our conviction, based on Dr. W. M. Mann's extensive collections of 1912–13, of the richness and striking endemicity of the ant-fauna of Hispaniola. Dr. Darlington's success was due not only to his very unusual ability as a collector, but also to the fact that he is the first entomologist to explore the Massif de la Hotte in the southwestern peninsula of the island and to climb its high summit.

Family FORMICIDAE

Subfamily PONERINÆ

Platythyrea punctata F. Smith. Dominican Republic: San Lorenzo ☿ (Watson).

EMERYELLA SCHMITTI MINOR subsp. nov.

Worker. Length about 5.5—7 mm.

Averaging decidedly smaller than the typical *schmitti* and with the striation of the head, thorax and petiole distinctly coarser and sharper. Color darker; head, thorax, mandibles and scapes black; funiculi fuscous except at their tips.

Four specimens taken by Dr. Darlington in the northeastern foothills of the Massif de la Hotte, 3000 ft.

Euponera (*Trachymesopus*) *stigma* Fabr. Haiti: Northeastern foot-hills of the Massif de la Hotte, 3000–4000 ft. ☿ ; La Visite 6000–7000 ft. ♀ ☿ and Ennery ♀ (Darlington).

Ponera ergatandria Forel. Mona Island ☿ (Lutz); Haiti: Kenscoff 4500–5000 ft. ☿ (Darlington).

Ponera foeda Forel. Haiti: North-eastern foot-hills of the Massif de la Hotte, 3000 ft. ☿ (Darlington). Dominican Republic: Sanchez ☿ ♀ ♂ (Watson); Mona Island ☿ (Lutz).

Ponera opaciceps Mayr. Haiti: Etang Lachaux ☿, and northeastern foot-hills of the Massif de la Hotte, 3000 ft. ♀ (Darlington).

Leptogenys (*Lobopelta*) *antillana* Wheeler and Mann. Haiti: Etang Lachaux ☿ (Darlington).

ANOCHETUS (STENOMYRMEX) HAYTIANUS LONGISPINA subsp. nov.

Worker. Differing from the typical *haytianus* in having the head slightly narrower behind, with distinctly longer and more slender antennal scapes and funiculi, and in the greater length of the petiolar spines, which are fully twice as long as those of *haytianus*. The coloration is also different, the head and thorax being darker and distinctly red as are also the tibiæ. The transverse striation of the thorax, especially in the epinotal region, is distinctly coarser, the middle of the pronotum smoother and more shining.

Six specimens taken by Dr. Darlington in the northeastern foot-hills of the Massif de la Hotte, Haiti, 3000–4000 ft. One of them has a much more voluminous gaster than the others and seems to be an apterous female. It has no traces of ocelli and there are no differences in the head, thorax or petiole.

Odontomachus haematoda insularis Guérin. Mona Island ☿ (Lutz). Dominican Republic: Sanchez, Samana and Villa Rivas ☿ ♂ (Watson). Haiti: Etang Lachaux ♀ (Darlington).

Odontomachus haematoda paucidens Emery. Haiti: Port au Prince, northeastern foot-hills of the Massif de la Hotte, 3000–4000 ft. and Miragoane ☿ ♀ (Darlington); Morne Rochelois, Hinche and Miragoane ☿ (Eyerdam).

Subfamily PSEUDOMYRMINÆ

Pseudomyrma haytiana Forel var. *affinis* Wheeler and Mann. Haiti: Mt. Trou d'Eau ☿ and hills north of Port au Prince ♀ (Darlington). Forel regarded *haytiana* as a subspecies of the Central American *championi* Forel, but it seems to me to deserve specific rank.

Pseudomyrma haytiana var. *torquata* Wheeler and Mann. Dominican Republic: Sanchez ☿ and Samana ☿ (Watson).

Subfamily MYRMICINÆ

Pogonomyrmex (*Ephebomyrmex*) *saucius* Wheeler and Mann. Haiti: Port au Prince ☿ (Darlington).

Pogonomyrmex (*Ephebomyrmex*) *schmitti* Forel. Haiti: Manneville ☿ (Darlington).

The specimens are distinctly darker than the cotype of *schmitti* in my collection and the specimens collected by Mann at Cape Haitien, Furcy and Diquini, but as they exhibit no other perceptible differences I have not described them as a distinct variety.

Pogonomyrmex (*Ephebomyrmex*) *schmitti sublaevigatus* Wheeler and Mann. Port Terre Rouge, 2000 ft. ♀ (Darlington).

A single specimen which may belong to a distinct variety. It differs from the cotypes of *sublaevigatus* in being darker and in having the peduncle of the petiole and the anal segments black instead of reddish yellow. The rugæ on the petiolar node are few, longitudinal and rather vague. I believe that *sublaevigatus*, originally described as a variety, should be raised to subspecific rank.

POGONOMYRMEX (EPHEBOMYRMEX) SCHMITTI ATERRIMUS subsp. nov.

Worker. Differing from the typical *schmitti* in being coal-black throughout, with only the apical portions of the mandibular blades and terminal tarsal joints brown, whereas the typical *schmitti* is brown-black or reddish brown, with red mandibles, and brown legs and tips of epinotal and metasternal spines. Moreover, the whole body of *aterrimus*, except the posterior half of the first gastric segment and the following segments is decidedly more opaque, the thoracic rugosity coarser, the dense punctuation of the petiolar node, postpetiole and anterior half of the first gastric segment decidedly sharper. Epinotal spines longer; petiolar node narrower, less expanded anteriorly, with the anterior end more acuminate and pointed and its dorsal surface more coarsely and irregularly rugose.

Described from three specimens taken by Dr. Darlington between La Visite and Kenscoff, Haiti, at an altitude of 5000–7000 ft. The altitude and deep coloration suggest that *aterrimus* is a distinctly subalpine form.

POGONOMYRMEX (EPHEBOMYRMEX) SCHMITTI DARLINGTONI subsp. nov.

Worker. Resembling *aterrimus* in its opacity and coal-black coloration, but with even longer and more slender epinotal spines (twice as long as the metasternal spines). The petiolar node is similarly narrowed (fully one and one-half times as long as broad) and pointed anteriorly. The thorax in profile is less convex than in the other forms of *schmitti*, with less regularly arcuate outline and its coarse dorsal sculpture is more irregular, vermiculate-reticulate, without

longitudinal trend of the rugæ. The whole gaster is opaque, finely and densely punctate. Tips of epinotal and metasternal spines, petiolar peduncle, dorsal surface of postpetiole, except posteriorly, and the anterior half of the dorsum of the first gastric segment, yellowish red. Anal segments reddish; sting yellow. Mandibles dark brown.

Described from six specimens taken by Dr. Darlington in the northeastern foot-hills of the Massif de la Hotte at an altitude of 3000–4000 ft. This beautiful ant might be regarded as a distinct species were it not that the subspecies *aterrimus* seems to connect it with the typical *schmitti* and its subsp. *sublaevigatus*. *P. saucius* and *schmitti* constitute an isolated "Formenkreis" which is confined to Haiti.

Veromessor relictus epinotalis Wheeler and Mann. Haiti: Mt. Trou d'Eau, 4500 ft. ☿ (Darlington).

Pheidole fallax jelskii Mayr var. *antillensis* Forel. Haiti: Ennery ♀ ♀ (Darlington). Dominican Republic: San Lorenzo ♀ ☿ and Sanchez ☿ (Watson).

Pheidole megacephala Fabr. Haiti: Northeastern foot-hills of the Massif de la Hotte, 3000 ft. ♀ ☿ ♀ (Darlington); Top of Mt. Rochelois ♀ ☿ (Eyerdam). Dominican Republic: Samana, San Lorenzo and Sanchez ♀ ☿ (Watson).

Pheidole moerens Wheeler var. *creola* Wheeler and Mann. Haiti: Northeastern foot-hills of the Massif de la Hotte, 3000 ft. ♀ ☿ (Darlington).

The soldier differs from that of the typical *jamaicensis* in having the rugules on the front and sides of the head distinctly finer and more delicate and the median portions of the femora and flexor surfaces of the tibiæ dark brown. The worker and female show the same color differences of the legs and also have the antennal clubs brown. The specimens from Petionville, Haiti, referred by Mann and myself to the typical *jamaicensis*, really belong to this variety.

Five soldiers, six workers and two winged females taken by Darlington in the northeastern foot-hills of the Massif de la Hotte, 3000–4000 ft.,

PHEIDOLE DARLINGTON sp. nov.

Worker. Length 1.3 — 1.5 mm.

Head subrectangular, slightly longer than broad, as broad in front as behind, with nearly straight sides and feebly concave posterior border. Eyes small, consisting of only about a dozen unequal ommatidia, situated just in front of the median diameter of the head. Mandibles rather large, with two larger apical and several minute basal teeth. Clypeus convex, with distinct median carinula and

broadly rounded, entire anterior border. Frontal area elongate-triangular, with median carinula. Antennæ slender; scapes extending beyond the posterior border of the head to a distance equalling their greatest diameter; funicular joints 2–8 as long as broad, the 3-jointed club as long as the remainder of the funiculus, its two basal joints longer than broad, together shorter than the distinctly swollen terminal joint. Promesonotum convex, subhemispherical, slightly abrupt and angular in profile behind where it falls to the pronounced mesoëpinotal impression; humeri feebly angular; promesonotal suture obsolete. Epinotum subcuboidal, decidedly lower and narrower than the promesonotum, with subequal base and declivity, the former nearly straight, horizontal, the latter sloping, the spines suberect, small, acute, longer than broad at their bases. Petiole slender, about three times as long as broad, parallel-sided, the node at the posterior third, rounded-cuneate in profile, its summit straight and transverse. Postpetiole slightly broader than the petiole, subglobular, its dorsal surface lower than the petiolar node. Gaster broadly elliptical, somewhat smaller than the head.

Mandibles smooth and shining, with fine, scattered, piligerous punctures, obscurely striate at the base. Head, thorax and peduncle of petiole opaque, densely and evenly punctulate; cheeks and clypeus also feebly, longitudinally rugulose; petiolar node, postpetiole, gaster, scapes and legs very smooth and shining.

Hairs yellowish, moderately long and sparse, erect or suberect, longest on the thorax and gaster, shorter and more oblique on the scapes and legs. Pubescence absent.

Sordid yellowish white; scapes, bases of coxæ, femora, except their bases and tips, petiolar node, postpetiole, gaster, clypeus, front, sides of head and a small circular spot on the vertex, black or dark brown.

Six specimens taken by Dr. Darlington in the northeastern foothills of the Massif de la Hotte, at an altitude of about 3000 ft. I have ventured to base this species on the worker because it can be readily recognized by the singular coloration, which is unlike that of any worker Pheidole known to me, though resembling that of the soldier of the typical *punctatissima* Mayr.

Cardiocondyla emeryi Forel. Mona Island ☿ ♀ (Lutz).

Cardiocondyla venustula Wheeler. Mona Island ☿ (Lutz).

Crematogaster (*Orthocrema*) *steinheili* Forel. Dominican Republic (Aug. Busck) ♀.

Monomorium carbonarium ebeninum Forel. Dominican Republic: Sanchez ☿ ♀ (Watson).

Solenopsis (*Solenopsis*) *geminata* Fabr. Haiti: Hinche ♀♀ and Top of Mt. Rochelois ♀ (Eyerdam) Ennery, Miragoane and northeastern foot-hills of the Massif de la Hotte ☿ (Darlington). Dominican Republic: Sanchez, Villa Rivas and San Lorenzo ☿ (Watson).

Solenopsis (*Diplorhoptrum*) *corticalis* Forel. Mona Island ♀☿ (Lutz).

Macromischa (*Macromischa*) *sallei haytiana* Wheeler and Mann. Haiti: La Visite, 6000–7000 ft. ☿ (Darlington).

Macromischa (*Macromischa*) *sallei opacinoda* Wheeler. Haiti: Roche Croix, La Hotte, 5000 ft. ☿ (Darlington).

Tetramorium guineense Fabr. Dominican Republic: Sanchez ☿ (Watson).

Wasmannia auropunctata Roger. Mona Island ☿ (Lutz). Haiti: Morne Rochellois ☿ (Eyerdam); Hills north of Port au Prince ☿ (Darlington). Dominican Republic: Villa Rivas ☿ (Watson).

HYPOCRYPTOCERUS Mann

Emery, in the Myrmicine section of the "Genera Insectorum" (1921), has divided the peculiar tribe Cryptocerini into four genera: Procryptocerus Emery, Cephalotes Latreille, Zacryptocerus Ashmead and Cryptocerus Latr. The last of these he subdivided into three subgenera: Paracryptocerus Emery, Cryptocerus *sens. str.* and Cyathocephalus Emery (a preoccupied name recently replaced by Cyathomyrmex Creighton). Like the very distinct genus Procryptocerus, Cephalotes and Zacryptocerus are characterized by having monomorphic workers, whereas these are sharply dimorphic in Cryptocerus *sens. lat.* Emery erroneously included in his subgenus Cryptocerus the species *haemorrhoidalis* Latr. (1802), which has monomorphic workers and should therefore be regarded as the type of a distinct genus for which the name Hypocryptocerus is proposed.[1]

There are now before me specimens of no less than six different forms of Hypocryptocerus that agree with Latreille's description of *haemorrhoidalis* except in certain subspecific or varietal characters. Moreover, down to the present time no form corresponding in all respects with Latreille's account has been recovered. His description of the type, which was taken by Geoffroy de Villeneuve at Santo Domingo, is in part peculiarly disconcerting. In his diagnosis the specimen is said to have the "tête mutique; ses bords latéraux et l'anus rougeâtres (capite mutico, lateribus anoque rubescentibus)", but in the more detailed French description we have the statement "l'anus a une grande tâche rougeâtre separée au mileu par un trait longitud-

[1] Mann, in his paper on West Indian ants (1920) has used this name as a subgeneric designation for *haemorrhoidalis*, probably as the result of a conversation with me several years ago. Menozzi more recently (1930) has assigned this ant to Procryptocerus, regarded as a subgenus, apparently over-looking the fact that Procryptocerus is a clearly defined, neotropical genus not known to occur in the West Indies.

inal, formé de l'empiétement du noir en cette partie." In our paper on the ants of Haiti (1914), Mann and I conjectured that Latreille's description might have been based on an immature specimen with red anal region, but belonging to the form later (1863) described by Roger as *Cryptocerus hamulus* and by Forel (1901) as *C. haytianus*. We therefore regarded these forms as synonymous with *haemorrhoidalis*. But two of the forms described below, namely the subspecies *steinheili* Forel and *signatus* subsp. nov., have the dorsal surface of the first gastric segment reddish yellow, with a very conspicuous black, posteromedian spot or stripe, so that if we suppose Latreille to have employed the term "anus" in a quite unjustifiable sense, it is conceivable that he may have had before him a similar form but one with less of the first gastric segment reddish yellow. It is clear, at any rate, that unless his type specimen still exists or unless specimens turn up that agree more closely with his description than any since collected in Haiti or the Dominican Republic, we shall have to regard the identity of the true *haemorrhoidalis* as questionable. I have described all the following variants as subspecies though some of them have more pronounced characters than others. Very probably more forms will be discovered by future collectors, so that my study of this interesting Formenkreis must be fragmentary and provisional. Mann and I described the male of *haemorrhoidalis* but the female has never been seen, though this caste is common in collections of Cryptocerus *sens. lat.*

HYPOCRYPTOCERUS HAEMORRHOIDALIS HAMULUS Roger

Worker. This subspecies, of which Forel's var. *haytianus* is merely a synonym, as is evident from examination of a cotype in my collection, has the epinotal declivity densely punctate, without longitudinal rugæ or with only faint traces of them on the sides. The lateral borders of the mesonotum are distinctly dentate, the epinotal spines as long as the base of the epinotum, suberect, posteriorly diverging and slightly curved forward. The base of the first gastric segment is longitudinally rugulose. The hairs are yellowish, on the head, thorax and pedicel partly moderately long, erect, delicate and of uneven length, partly appressed, short, flattened and scalelike. These hairs are almost or quite absent on the dorsal surface of the gaster, the long erect hairs sparse and most numerous on its posterior portion. Black, except the expanded lateral margins of the head, the scapes and bases of funiculi, which are reddish yellow or testaceous, and the tips of the epinotal spines, knees and terminal tarsal joints, which are reddish brown.

The Haitian specimens from Port au Prince, Manneville, Diquini, Ennery and the mountains north of Jacmel, which Mann and I referred to the typical *haemorrhoidalis*, belong to this subspecies.

HYPOCRYPTOCERUS HAEMORRHOIDALIS AFFINIS subsp. nov.

Worker. Very similar to the worker of *hamulus* in scupture, pilosity and color, but the epinotal declivity is strongly and regularly, longitudinally rugose and the basal rugules of the first gastric segment are distinctly finer and more numerous. The epinotal spines are distinctly longer and more tapering and the sides of the mesonotum are more rounded and edentate. The anterior corners of the petiolar node, however, are sharply dentate.

Described from two workers taken by Dr. Darlington at Poste Terre Rouge, Haiti, at an altitude of about 2000 ft.

HYPOCRYPTOCERUS HAEMORRHOIDALIS AURICOMUS sp. nov.

Worker. Like *affinis* in color and sculpture but with somewhat less pronounced longitudinal rugæ on the epinotal declivity, without rugules on the base of the first gastric segment and with much more abundant and golden yellow pilosity. The appressed scale-like hairs are very conspicuous, on both the dorsal and pleural surfaces of the thorax and especially dense on the base of the epinotum. The erect or suberect hairs are also more numerous, coarser, more flexuous and more scale-like than in the preceding subspecies. The gaster which in these subspecies has very few hairs, is covered in *auricomus* with short, golden, appressed scale-like pilosity, which is very regular though not sufficiently dense to conceal the underlying surface. The epinotal spines are stout and straight, shorter than the base of the epinotum and directed backward and outward. The anterior corners of the petiolar node are angulate but not dentate.

Described from numerous specimens taken by Mr. Watson at Sanchez, in the Dominican Republic.

HYPOCRYPTOCERUS HAEMORRHOIDALIS VINOSUS subsp. nov.

Worker. Sculpture and coloration as in *affinis*, except that the base of the first gastric segment is very finely and indistinctly rugulose and its whole dorsal surface of a purplish maroon-color. The declivity of the epinotum is sharply and regularly, longitudinally rugose, the spines shorter than the base, slender, tapering, directed backward and out-

ward as in *auricomus*, but distinctly turned upward at their tips. Pronotal teeth long, blunt and flattened. Anterior corners of petiole angulate but not dentate; lateral spines of postpetiole broad and rather flat.

Pilosity whitish or pale yellowish, moderately abundant, the erect hairs blunt, coarse and somewhat flattened, almost absent on the upper surface of the gaster; blunt on the legs; the short, appressed hairs rather sparse on the thorax, very short on the anterior portion of the head.

Described from numerous specimens taken by Mr. Eyerdam on Mt. Rochelois, Haiti and accompanied by the note: "nesting in a beech; very pugnacious."

HYPOCRYPTOCERUS HAEMORRHOIDALIS STEINHEILI Forel

Worker. A single specimen from Samana, Dominican Republic (Watson) agrees perfectly with Forel's description of this subspecies, which has the dorsal surface of the first gastric segment reddish yellow, with a broad black median stripe extending from the middle of the first segment to the posterior border where it expands somewhat. There are no rugules on the base of the gaster. The pronotal spines are rather small and acute, the sides of the mesonotum short and edentate, the epinotal spines acute, nearly straight, as long as the base of the epinotum, directed upward, outward and backward. Anterior corners of petiolar node distinctly dentate; lateral spines of postpetiole as in *vinosus*. Pilosity similar.

The type of this subspecies, according to Forel, was collected by Henri de Saussure on the island of St. Thomas, but the locality seems to me to be doubtful. De Saussure collected in 1857 both in St. Thomas and Haiti, and neither Forel nor I found this ant on the former island. *Camponotus* (*Myrmeurynota*) *saussurei*, which, according to Forel, was also collected by de Saussure in St. Thomas, seems to be open to the same suspicion. It is closely related to *C.* (*M.*) *toussainti* of Haiti and like *Hypocryptocerus steinheili* has not since been found on St. Thomas. Perhaps the two types in question may have been collected near Thomazeau, a town in Haiti.

HYPOCRYPTOCERUS HAEMORRHOIDALIS SIGNATUS subsp. nov.

Worker. At first sight easily confused with *steinheili* but quite distinct. The color of the gaster is very similar but the black stripe is much broader and more expanded anteriorly so that it is subtri-

angular. The epinotal declivity is coarsely and *transversely* rugose, the epinotal spines are decidedly longer than in any of the preceding subspecies, slender but not tapering, directed upward and outward, but only slightly backward, with the tips blunt and curved forward. The pronotal spines are rather long and acute, the sides of the mesonotum indistinctly dentate, the anterior corners of the petiolar node acutely dentate. Pilosity golden yellow, the erect hairs on the thoracic dorsum and posterior portion of head abundant, straight and of even length, the appressed squamiform hairs on the head and gaster very short, on the latter minute and sparse but distributed over the whole surface; hairs on legs white, short, sparse and blunt.

A single specimen taken by Dr. Darlington on the summit of Mt. Basil, Haiti, at an altitude of about 4500 ft.

Cryptocerus (*Cyathomyrmex*) *varians marginatus* Wheeler and Mann. Haiti: Manneville ☿ (Darlington).

Mycocepurus smithi Forel. Dominican Republic: San Lorenzo ☿ (Watson).

CYPHOMYRMEX RIMOSUS MINUTUS Mayr var. FLAVIDUS var. nov.

Worker. Length 1.4 — 1.5 mm.

Distinctly smaller than *minutus* and differing in coloration, being clear yellow, with the head, excepting the mandibles and borders of frontal lobes, and the first gastric segment, except its posterior border, brown.

Two workers from the northeastern foot-hills of the Massif de la Hotte, 3000, and one from Étang Lachaux, southwestern Haiti (Darlington).

Trachymyrmex jamaicensis Ern. André. Mona Island ☿ (Lutz). Haiti: Miragoane ☿ (Eyerdam).

Subfamily DOLICHODERINÆ

Iridomyrmex keiteli Forel var. *flavescens* Wheeler and Mann. Haiti: Northeastern foot-hills of the Massif de la Hotte, 3000 ft. ☿ (Darlington).

Dorymyrmex pyramicus Roger var. *niger* Pergande. Mona Island ☿ ♂ (Lutz).

Tapinoma melanocephalum Fabr. Mona Island ♀ (Lutz).

Subfamily FORMICINÆ

MYRMELACHISTA GAGATES sp. nov.

Worker. Length 1.7 mm.

Very similar to *rogeri* Ern. André of Cuba, but differing in the shape

of the head, thorax and petiole, in color and pilosity. Head larger and more sharply rectangular, less narrowed in front, where it is as broad as behind. Eyes larger. Promesonotum longer and somewhat less convex above, epinotum proportionally longer and broader. Petiolar scale decidedly thicker, with convex anterior surface and very sharp superior border, which is more deeply and more angularly excised than in *rogeri*.

Very smooth and shining, like *rogeri*, with similar pilosity, but the hairs on the gaster less numerous and longer. Jet black; antennæ and mandibles dark brown, scapes darker and more blackish, their tips and the basal funicular joints yellowish brown; femora black; tibiæ very dark brown, paler at their bases and tips; tarsi and tibial spurs brownish yellow; last tarsal joint of each leg blackish.

Described from a single specimen taken by Dr. Darlington at La Visite, 6000–7000 ft., Haiti.

Camponotus (*Tanaemyrmex*) *picipes plombyi* Wheeler and Mann. Haiti: Between Kenscoff and La Visite, 5000–7000 ft. ☿ (Darlington).

Camponotus (*Tanaemyrmex*) *larvigerus* Wheeler and Mann var. *maculifrons* Menozzi. Mona Island (Lutz). Numerous major and minor workers agreeing perfectly with the description of Menozzi's material from Santo Domingo and Los Siete Hermanos Islands.

Camponotus (*Tanaemyrmex*) *fumidus* Roger var. *illitus* Wheeler and Mann. Haiti: Hinche ☿ (Eyerdam); Kenscoff ☿ (Darlington).

Camponotus (*Tanaemyrmex*) *fumidus haytianus* Wheeler and Mann. Haiti: Summit of Mt. Rochelois ☿ (Eyerdam); Northeastern foot-hills of the Massif de la Hotte ☿ (Darlington).

CAMPONOTUS (TANAEMYRMEX) USTUS Forel

In the "Genera Insectorum" Emery places this West Indian ant, of which four different forms are known to occur in Haiti, in the subgenus Pseudocolobopsis, but there seems to be no doubt of its being a Tanaemyrmex. As Forel noticed in 1879, it is related to *fumidus* Roger, though it is decidedly smaller and differently sculptured. It is even more closely allied to *ramulorum* Wheeler, which Emery has placed in Tanaemyrmex. The following undescribed varieties of these two species are sufficiently distinct to deserve names.

CAMPONOTUS (TANAEMYRMEX) USTUS var. DEPOLITUS var. nov.

Worker major. Length 6—6.5 mm.

Closely resembling the var. *ulysses* Forel, but the head is distinctly

narrower and more shining, with less pronounced punctures on the cheeks, which are naked and hairless. The clypeus is more sharply carinate, its anterior lobe more distinct and projecting. Mandibles and head dark brown, except the extreme occipital border and posterior corners which are yellow. Median portion of scapes distinctly infuscated. Dorsal surface of thorax brown, clouded with brownish yellow; dorsum of gaster pale brown, not fasciate, though the basal and apical borders of the segments are yellow. Coxæ, femora, petiole and much of venter pale whitish yellow; tibiæ darker and more reddish like the tarsi. Yellow erect pilosity on the dorsal surface of the body, especially on the front clypeus and scapes, decidedly less abundant than in the typical *ustus* and the variety *ulysses;* on the tibiæ much shorter and finer, reduced to a very delicate pubescence.

Worker minor. Length 5.5 mm.

Very similar to the worker minor of *ulysses* but the head is broader in proportion to its length and the erect hairs on the head and gaster are distinctly less numerous. Dorsal surface of head, thorax and gaster darker and more brownish than the remainder of the body. Antennal scapes not infuscated. Pubescence on scapes and tibiæ shorter than in the var. *ulysses.*

Male. Length 6 mm.

Pale yellowish brown; mandibles, clypeus, palpi, funiculi, legs, genitalia and anterior and posterior borders of gastric segments pale yellow; wings yellowish hyaline, with pale yellow veins and stigma.

Described from two major workers, one minor worker and a male from Sanchez, Dominican Republic (Watson).

CAMPONOTUS (TANAEMYRMEX) RAMULORUM Wheeler var. VERNULA var. nov.

Worker major. Length 4.5 — 5 mm.

Smaller than the typical *ramulorum* from the Bahamas and differing in coloration. Mandibles and whole head, except the posterior corners, very dark brown, as are also the antennal scapes, except their bases. Thorax also darker brown above than in *ramulorum,* with the yellow maculæ smaller; gaster paler brown, with yellow posterior borders to the segments but appearing much less distinctly fasciate than in the typical form of the species. Tibiæ and knees reddish. The coarse punctures on the cheeks and clypeus are much more pronounced than in *ramulorum* and the occiput has a row of coarse, elongate punctures.

Worker minor. Length about 4 mm.

Also smaller than the worker of the typical *ramulorum;* head, mesonotum, mesopleuræ and dorsal surface of gaster distinctly brown; antennæ, knees and tarsi more reddish.

Described from five major and two minor workers taken by Dr. Darlington in the northeastern foot-hills of the Massif de la Hotte, Haiti, at an altitude of 3000–4000 ft.

Camponotus (*Myrmeurynota*) *christophei* Wheeler and Mann. Haiti: One major worker from Ennery and two from Mt. Trou d'Eau (Darlington).

Camponotus (*Myrmeurynota*) *augustei* Wheeler and Mann. Haiti: Northeastern foot-hills of the Massif de la Hotte, 3000–4000 ft. ♀ ; Camp Perrin, 3000 ft. ♀ ; Port au Prince ♀ ; Trou d'Eau, 4500 ft. ♀ ; Above Furcy ♀ (Darlington). This additional material indicates that *augustei* is to be regarded as an independent species and not as a subspecies of *christophei.*

Camponotus (*Myrmeurynota*) *toussainti* Wheeler and Mann. Haiti: One minor worker from La Visite, 6000–7000 ft. (Darlington).

CAMPONOTUS (MYRMEURYNOTA)ALTIVAGANS sp. nov.

Worker major. Length 5.5 — 6.5 mm.

Head trapezoidal, as broad as long, with straight posterior border and feebly convex, anteriorly converging sides. Eyes moderately large, at the posterior third of the head, without clearly developed ridges between the posterior orbits and posterior corners. Mandibles stout and convex, apparently 5-toothed, the apical tooth longer and stouter than the four subequal, narrow basal teeth. Clypeus trapezoidal, as long as broad, carinate basally, the anterior border broadly rounded in the middle and deeply sinuate on each side. Frontal area distinct, transversely triangular; frontal carinæ anteriorly approximated, widely diverging behind; frontal groove distinct. Antennæ slender; scapes curved at base, distinctly thickened distally, extending about two-fifths their length beyond the posterior border of the head. Thorax in profile evenly but not very convexly arcuate as far as the posterior end of the base of the epinotum, where it rounds into the rather steeply sloping declivity, which is of the same length as the base. Promesonotal suture impressed; mesoëpinotal suture indistinct. From above the pronotum is flattened, nearly as long as broad, produced in the middle anteriorly, the sides rounded, marginate anteriorly at the humeri and halfway back to the promesonotal suture, the anterior and inferoanterior border of the pronotum developed as a narrow subtransparent lamella. Mesonotum also somewhat flattened above, slightly broader than long, subtrapezoidal, its sides rounded and converging posteriorly. Petiolar scale inclined forward, oval, rather thick,

with convex anterior and flattened posterior surface and rather blunt superior border. Gaster broadly elliptical, the first segment flatly truncated anteriorly. Legs stout; fore femora enlarged.

Subopaque; gula, posterior corners of head, venter and legs more shining. Mandibles finely shagreened and coarsely and sparsely punctate. Head, thorax and petiole densely and finely punctate or sharply reticulate, with coarse, scattered, piligerous punctures, which are lacking on the sides of the thorax, where the sculpture becomes more punctulate-striolate. Gaster above very finely, sharply and transversely striolate-reticulate, with sparse, coarse, transverse, piligerous punctures. Venter smoother; scapes more sharply, legs more superficially shagreened.

Pilosity consisting of flattened or scalelike hairs, partly white, erect, longest on the epinotum, border of petiolar scale and dorsal surface of gaster and short on the head and clypeus, and partly yellowish and appressed, directed forward on the head and thorax and backward on the gaster. Pilosity on legs simple, very sparse, short and appressed, except for a row of long hairs on the flexor surfaces of the femora and a few bristle-like hairs at their tips.

Black; mandibles, except their teeth, scapes and base of petiole red; funiculi fuscous; posterior borders of gastric segments sordid yellowish; legs reddish testaceous, tarsi darker red.

Worker minor. Length 4 mm.

Differing from the major in the following characters: Pronotum proportionally broader, less produced anteriorly in the middle, its sides sharply marginate or sublaminate throughout; epinotum more strongly narrowed behind and in profile distinctly angular, the declivity longer than the base, more abrupt and decidedly concave. Appressed flattened hairs as numerous and as long on the head as on the thorax and gaster, but absent on the sides as they are on the pleuræ. Sides and posterior corners of head reddish; whole petiole red or testaceous; scapes as pale as the legs.

Described from three major and three minor workers taken by Dr. Darlington between La Visite and Kenscoff. Without the minor worker one might be tempted to place this species in the subgenus Myrmobrachys because the lateral borders of the pronotum are so much less expanded than in the other Haitian species of Myrmeurynota.

CAMPONOTUS (MYRMEURYNOTA) ALBISTRAMINEUS sp. nov.

Worker minor. Length 4.3 mm.

Head nearly as broad as long, subtrapezoidal, narrowed anteriorly,

with rounded sides and posterior corners and feebly convex posterior border. Eyes rather large and flat, placed well behind the median diameter of the head. Mandibles rather large, convex, 5-toothed, the apical tooth much longer than the broad, subequal basal teeth. Clypeus trapezoidal, broader than long, ecarinate and not very convex in the middle, the anterior border broadly rounded, very slightly produced medially and feebly sinuate on each side. Frontal area and frontal groove obsolete; frontal carinæ sigmoidal, distinctly elevated and widely diverging posteriorly. Antennæ long and slender; scapes only feebly curved at the base, extending about two-fifths their length beyond the posterior border of the head. Thorax rather short and high, its dorsal outline strongly arcuate, interrupted only by the impressed promesonotal suture and a very obtuse angle separating the base of the sloping declivity from its distinctly longer and more abrupt declivity. Mesoëpinotal suture obsolete. From above the thorax is about twice as long as broad, gradually narrowed posteriorly; pronotum about one and two-thirds as broad as long, somewhat narrower behind than in front, with feebly rounded, sharply marginate sides which are expanded into bluntly angular and slightly upturned lamellæ at the humeri; mesonotum subelliptical, nearly twice as broad as long; base of epinotum roof-shaped, its two halves meeting at a blunt but perceptible ridge in the median line. Petiolar scale from behind broad and suborbicular above, strongly narrowed ventrally, in profile high and moderately thick, with blunt superior border, feebly convex anterior and flat posterior surface. Gaster broadly elliptical, the first segment truncated anteriorly. Legs rather long, fore femora enlarged.

Opaque; venter, petiole and legs smoother and more shining. Mandibles finely shagreened and coarsely and sparsely punctate. Head and thorax finely, densely, sharply and very regularly punctulate; sides of thorax with the punctules arranged in parallel lines. Petiolar sculpture feebler, the posterior surface of the scale transversely striolate. Dorsal surface of gaster finely, sharply and transversely reticulate, with coarse, transverse, piligerous punctures. Venter and anterior truncated surface of first segment superficially shagreened or reticulate. Antennal scapes more opaque and more sharply and densely reticulate or granular.

Pilosity similar to that of *altivagans* but the hairs are snow white, the appressed ones on the head, thorax and gaster even more distinctly flattened and scale-like and with a more general distribution. Not only are there hairs of this type on the sides of the head but also on

the inferior border of the pronotum and in conspicuous tufts on the meso- and metasterna, middle and hind coxæ. Posterior faces of fore femora with similar but sparser and less flattened hairs. Knees and tips of tibiæ with a few conspicuous yellow bristles. Middle and hind femora and all the tibiæ with very sparse, simple hairs, or coarse, dilute pubescence; coxæ with finer, denser, appressed pubescence.

Coal black; gastric segments with dull whitish posterior borders; tips of tarsi dark brown; mandibles red, with black teeth; antennæ paler, yellowish red, or testaceous.

Described from a single specimen taken by Dr. Darlington on Mt. Trou d'Eau, 4000 ft., Haiti.

Paratrechina longicornis Latr. Haiti: Miragoane ☿ (Eyerdam).
Paratrechina longicornis var. *hagemanni* Forel. Mona Island ☿ (Lutz). Haiti: Miragoane ☿ (Eyerdam). Dominican Republic: Sanchez ☿ (Watson).
Nylanderia fulva Mayr. Dominican Republic: Sanchez, ☿ ♀ (Watson).
Nylanderia steinheili Forel. Haiti: Miragoane ☿ (Darlington).

NYLANDERIA DARLINGTONI sp. nov.

Worker. Length 1.8 — 2.4 mm.

Head subrectangular, slightly longer than broad, as broad in front as behind, with feebly and evenly convex sides and straight posterior border. Eyes rather large, moderately convex, at the middle of the sides. Mandibles narrow, with oblique 6-toothed blades, the third and fifth tooth from the apex smaller than the others. Clypeus convex and subcarinate in the middle, its anterior border entire and broadly rounded. Frontal area large but indistinct. Antennæ long and slender; scapes extending about two-fifths of their length beyond the posterior border of the head; second funicular joint small, broader than long, joints 3–10 subequal, nearly twice as long as broad, terminal joint nearly as long as the two preceding joints together. Thorax in profile with feebly convex promesonotum, gradually rising to the mesoëpinotal impression which is very short, abrupt and shallow, the epinotum rising somewhat behind it to form a very short base and then falling in a very flat curve to the metasternal angles. Seen from above the thorax is about two and one-half times as long as broad, somewhat broader through the pronotum than through the posterior rectangular portion of the epinotum; pronotum broader than long, mesonotum longer than broad; metanotal spiracles not prominent, separated by a distance equal to fully three times their diameter. Petiole with low,

thick, anteriorly inclined node, half as broad as the epinotum, with straight, transverse, blunt summit, its sides converging inferoposteriorly, its posterior surface feebly convex. Gaster rather large, convex dorsally, with acute tip, the first segment shaped as in *Prenolepis imparis* Say, with a concavity for the reception of the petiolar scale, medially marginate above and acutely angular on each side. Legs rather long and slender.

Very smooth and shining, with fine, sparse, piligerous punctures; gaster delicately shagreened. Mandibles finely, longitudinally striolate. Legs and scapes less shining, very finely and densely punctulate.

Hairs on gaster and dorsal surface of head and pronotum yellowish, erect, sparse and tapering. Pubescence appressed, rather long on the head, shorter and denser on the gaster and even finer and denser on the legs. There are no bristle-like erect hairs on the legs and scapes.

Sordid, pale yellowish brown or brownish yellow; dorsal surface of gaster darker brown; scapes and median portions of femora and tibiæ feebly infuscated; coxæ, trochanters and tarsi pale yellow; mandibles reddish, with darker reddish teeth.

Described from seven workers taken by Dr. Darlington between La Visite and Kenscoff, Haiti, at an altitude of 5000–7000 ft. Except in the structure of the thorax, this ant seems to be more like a Prenolepis than a Nylanderia. The larger specimens are true repletes, with greatly distended gaster, like the repletes of our common North American *P. imparis* Say.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
VOL. LXXX, NO. 3

NEW JAMAICAN AND CUBAN MILLIPEDS, WITH NOTES ON SEVERAL OTHER SPECIES

BY H. F. LOOMIS

Bureau of Plant Industry
U. S. Department of Agriculture

WITH ONE PLATE

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
JANUARY, 1937

No. 3 — *New Jamaican and Cuban Millipeds, with Notes on Several Other Species*

By H. F. Loomis

Bureau of Plant Industry
U. S. Department of Agriculture

The millipeds dealt with in this paper were received for identification from the Museum of Comparative Zoölogy, Cambridge, Massachusetts. Two of the species were collected in Jamaica by Dr. P. J. Darlington, and seven species were collected at Soledad, Cuba in 1932 by Dr. Marston Bates and Mr. Graham B. Fairchild, using a Berlese funnel. It appears that both of the Jamaican species and four of those from Cuba are new to science, and descriptions of these species, with notes on the other species and on closely related forms, are presented in the following pages.

Of especial interest in the Cuban collection was a specimen belonging in the family Sphaeriodesmidae, a Central American family never before reported from the West Indies, although it was subsequently discovered that a species from the Isle of Pines and another from Jamaica, attributed to the family Cyclodesmidae, actually were of the Sphaeriodesmidae. The Soledad specimen is referable to the former species.

Noteworthy additions to the Cuban fauna are *Docodesmus cubensis*, the initial representative of the genus in the island; and *Siphonophora senaria*, the smallest member of what is rapidly becoming a large tropical American genus.

Family SIPHONOPHORIDAE

Siphonophora senaria new species

Three males and three females collected with a Berlese funnel from "Forest floor," Soledad, Cuba, July 1932 by M. Bates and G. B. Fairchild.

Diagnosis. This is the smallest member of the genus and has fewer segments. The short, deceptively jointed, antennae are a structural peculiarity of the species.

Description. Body small, relatively broad, the largest specimen is a female only 6.2 mm. long and .5 mm. wide. Number of segments from 33 to 37. Color creamy white.

Dorsum flattened, densely hairy, with faintly evident lateral carinae bearing the pores.

Head pyriform, narrow, not over half the width of the second segment (Fig. 1); beak about half as long as the remainder of the head, slightly deflexed; antennae short and stout and quite unusual in that they appear to have only six joints, for without great care the first joint cannot be seen, as it is almost entirely concealed within the antennal socket and may only be seen in lateral view, hence, the second joint may easily be mistaken for joint 1; joint 3 is definitely longer than joint 2, apparently a unique condition, for with species where the antennae are described or figured the second joint is the longer (Fig. 2).

First segment with the rounded sides converging anteriorly, the front margin deeply, angularly, emarginate; median length of the dorsum nearly three times that of the second segment.

Sides of the body parallel to the antepenultimate segment where they converge rapidly to the small last segment.

Gonopods quite similar in general structure to those of *S. progressor* Chamberlin, from Central America.

This species probably is quite closely related to *S. cubana* Karsch, the only previously recorded species of the genus in Cuba, but several differences are evident; the size is smaller, the length of segment 1 is greater in comparison with segment 2; and it is quite probable that there are fewer segments although Karsch did not designate the number of segments for his species. No definite locality was given for *S. cubana*, and it has not been rediscovered since the original description appeared, although this is not an unusual circumstance for a small Cuban milliped, when many much larger ones have been collected only once, and it is certain that there are a great many undiscovered species of all sizes in the island.

Family STEMMIULIDAE

Prostemmiulus alveatus new species

Two fragments of a male in a bottle of millipeds from Soledad, Cuba, collected by M. Bates and G. B. Fairchild in July 1932 with a Berlese funnel. One fragment consists of the head and fifteen segments, the other fragment is composed of nine segments from the middle of the body.

Diagnosis. In external characters this species is distinguished by its markings; the strongly impressed dorsal striae; and the coarse ser-

rations along the ventral, posterior, margin of the segments. It appears to be quite close to *P. nesides* Chamberlin, from the Isle of Pines, but the dark head distinguishes it. The gonopods denote relationship with such Haitian species as *interruptus, subulatus,* etc., but show evident differences. It is to be regretted that *nesides* was founded on a female, for its relationship to the other species cannot be definitely known until males from the type locality are studied.

Description. Length of body unknown; width 1.5 mm.

In color the head is quite dark, in contrast to the first four segments, which are pinkish in alcohol, thereafter the anterior two-thirds of the segments is mostly dark with a narrow colorless median line, laterad of which the surface is dark for a short distance, then there is a mottled area surrounding the pore; below this area the sides are dark with light spots half way to the feet; ventral portion of the segments light colored or colorless; entire posterior third of the segments colorless.

Head without an impressed median sulcus on the vertex. Lower ocellus half as large as the upper one. Antennae with joint 2 longest; joint 3 next in length; joints 4 and 5 subequal, each half again as long as joint 6.

First segment with a furrow along the anterior margin extending from well above the upper ocellus around to the posterior margin. There are three short striae below this marginal furrow but none above it.

Body slightly constricted at segments 4 and 5. Ventral striae extending onto the dorsum at about segment 9, the striae more strongly impressed on the dorsum than in most other species; serrations along the lower posterior margin of the segments coarser than usual.

Male with the pleurae of the third segment slightly raised but not obscuring the pleural lobes of segment 4, the posterior corner of each broadly rounded. Pleura on each side of segment 4 produced and elevated into a rather narrow, triangular, lobe.

Gonopods as shown in figures 3 and 4.

Family EPINANNOLENIDAE

Epinannolene cubensis (Bollman)

Nannolene cubensis Bollman, Proc. U. S. Nat. Mus., **11**, p. 335, 1888.

Two young female specimens collected at Soledad, (Vilche's Potrero) Cuba, July 3, 1932 by M. Bates and G. B. Fairchild.

Family SPIROBOLIDAE

Rhinocricus cingendus new species

One male collected from Main Ridge, Blue Mts., Jamaica, 5000–7000 feet elevation, Aug. 17–19, 1934 by P. J. Darlington.

Diagnosis. This species is associated with *R. sabulosus* Pocock but has a solid dark band encircling the middle of each segment; the anal segment ends in an acute angle; and the gonopods are distinctive.

Description. Length 20 mm., width 2 mm.; number of segments 41.

Head bicolored, a thin dark line connects the eyes and from its middle a broad dark band descends over the front between the antennae and expands on either side along the posterior part of the clypeal region; clypeal region light colored; between the frontal dark band and the antenna on either side is a large reniform light area marked with fine dark reticulations; above the line connecting the eyes the vertex is similarly reticulated on a light ground. First segment with the anterior third solidly dark, the posterior two-thirds with a transverse maculate area on each side of the dark median line, posterior margin dark. Ensuing segments with the forebelt dark at middle and on the sides, the area adjacent to each scobina, and for a short distance below it, colorless; midbelt solidly dark on the dorsum. maculate with light on the sides; hindbelt colorless, transparent, the dark markings of the forebelt of the succeeding segment showing through it; last segment and preanal scale dark but the pigmentation irregular; anal valves uncolored.

Head with the antennae short and stout; labral pores two on each side; ocelli 6, 7, 7, 5, 2, counting from the back of the head.

First segment broadly rounded on the sides; with a fine raised rim extending nearly to the lower corner of the eye.

Second segment with a raised rim in front, below the first segment.

On the succeeding segments the transverse suture between the midbelt and hindbelt is impressed very lightly on the dorsum of only a few of the anterior segments and is not present on any segment thereafter; across the middle of the dorsum above the pores the segment is crossed by a somewhat irregular but strongly impressed sulcus, behind which are a few short, oblique, impressed lines; on the segments approaching the middle of the body these short lines become fewer but the sulcus sometimes is doubled for much of its length; the pores are followed by an impressed line; surface of the segments finely reticulated but shining.

Last segment rather long, ending in a slightly produced, acute apex which does not extend beyond the valves. Anal valves smooth, evenly but not greatly inflated, the margins meeting in a reentrant angle. Preanal scale nearly twice as broad as long, triangular, the lateral margins straight throughout their length to the acute apex.

Gonopods as shown in figures 5 and 6.

Ventral margin of the seventh segment raised into a high, thin crest behind the gonopods with its anterior face excavated to receive their tips.

Third pair of male legs with the coxae produced into rounded lobes; other legs not modified except to have an inflated pad beneath the outer joint.

Family CYCLODESMIDAE

Cyclodesmus irretitus new species

One mature male and several immature specimens collected with a Berlese funnel from "Forest floor" Soledad, Cuba, July 1932 by M. Bates and G. B. Fairchild.

Diagnosis. Apparently closest to the Haitian *C. nudatus* Loomis but the gonopods differ, being slightly more curved and of somewhat different shape.

Description. Length of male 8 mm., width 2.3 mm.

Surface shining, but faintly rugose as if the animals had been dried as they may have been.

Head with the furrow of the vertex terminating considerably above the level of the antennae. Antennae with joints 2 to 5 equal in length, joint 6 slightly longer; the antennae separated by a distance about equal to the diameter of one of the sockets. Lateral margin of the head continuous, slightly emarginate just behind the anterior corner, the margin with a distinct raised rim to near the anterior corner.

First segment more than twice as wide as long, the anterior margin broadly and evenly concave, paralleling the evenly convex posterior margin; anterior margin with a pronounced rim extending around the broadly rounded front corners; median surface slightly depressed.

Second segment with the lateral angles narrowly produced but failing to reach opposite the anterior angles of segment 1.

Third segment of the usual form, the anterior rim broad and strongly raised, followed by a pronounced channel.

Fourth segment with the lateral carinae narrowed and ending in a rather acute angle; posterior margin with a tiny nick or indentation just above the angle.

Ensuing segments not noticeably different from those of the species with posterior margins of the segments simple, not incised. First and second segment and some of those thereafter with a few dorsal hairs so irregularly placed that their distribution indicates they are all that remain of a larger number, most of which have been lost.

Gonopods as shown in figures 7 and 8.

Coxae of the four pairs of legs immediately preceding the gonopods, and the two pairs succeeding them, with a slight, rounded prominence at the apex on the inner side.

Sternum between the eighth legs of the male very narrow, less than half the diameter of one of the leg sockets.

It seems quite likely that dorsal hairs are more common in the species of this genus than has been supposed but, because these hairs are so small or so easily lost, they usually have escaped notice. Examination of carefully collected specimens might show that the possession of at least a few dorsal hairs was the rule in most of the species if not in all of them.

C. irretitus is the first member of the family to be found in Cuba, as a species previously described from the Isle of Pines, and naturally included in the Cuban fauna, was incorrectly referred to the Cyclodesmidae.

Family SPHAERIODESMIDAE

It was with considerable surprise that fragments of a species of *Sphaeriodesmus* were found in one of the bottles of millipeds from Soledad, Cuba, as the family Sphaeriodesmidae had not been previously recognized as part of the West Indian fauna. In the same bottle were specimens of a species of *Cyclodesmus,* to which genus the fragments were, at first glance, thought to belong, but closer scrutiny showed the error of this assumption.

In studying the specimens of *Cyclodesmus* they were compared with the description and illustrations of *C. pinetorum* Chamberlin, the only member of the family attributed to Cuba. It was observed that the illustrations of the gonopods and the segments at the anterior end of the body of *pinetorum* bore much closer resemblance to species of *Sphaeriodesmus* than to *Cyclodesmus,* and to settle the point the para-

type specimens of *C. pinetorum* and *C. bruesi*, the latter a Jamaican species said to be closely related and with quite similar gonopods, were secured from the Museum of Comparative Zoölogy for examination. This examination showed that both species belong in the genus *Sphaeriodesmus* and that the statements pertaining to segments 3 and 4 in the original descriptions of these species actually referred to segments 4 and 5 respectively. Furthermore, in the illustration of the "First five tergites, lateral view" of *C. pinetorum*, scarcely any of segment 1 is to be seen, segments 2 to 6 being emphasized. In none of the paratype specimens of *C. pinetorum* is the shape of the lateral keels as shown in this illustration, segment 4 having an acute posterior angle and segment 5 with the anterior half of the outer margin excised.

Sphaeriodesmus pinetorum (Chamberlin)

Cyclodesmus pinetorum Chamberlin, Proc. U. S. Nat. Mus., **61**, Art 10, pp. 16–17, illus., 1922.

The head and first ten segments and the last six segments of a male found in bottle with other millipeds collected with a Berlese funnel from "Forest floor" Soledad, Cuba, July 1932 by M. Bates and G. B. Fairchild.

In direct comparison with paratype specimens no differences were noted except the somewhat smaller size of the Soledad male. As this species was described as a member of the genus Cyclodesmus the following description has been prepared.

Description. The length of the complete male probably was about 9 mm., the width is 2.8 mm.

Vertex of the head distinctly furrowed at middle, the furrow lacking considerable of reaching opposite the antennae which are separated by a distance greater than the diameter of one of the sockets; joints 2 to 5 subequal in length; joint 6 distinctly longer.

First segment semi-elliptical, longer than a semi-circle; the anterior margin straight; posterior margin evenly rounded throughout; lateral angles broadly rounded.

Second and third segments sub-crescentic; the latter with the lateral keels much longer, thickened, and curving downward and backward.

Fourth segment larger than any other, the keels only faintly expanded forward in front, curved slightly caudad, ending in an acute angle.

Fifth segment with the anterior half of the outer margin of the carinae cut away, the excision receiving the posterior angle of the

carinae of segment 4 when the body is rolled into a ball; posterior angle broadly rounded.

The first five segments are shown in lateral view in figure 9.

Segments 6, 7, and 8 with the carinae outwardly rounded; on succeeding segments the outer margin of the carinae is lengthened and on segments 16 to 19 the posterior corners are produced into short but very acute teeth (Fig. 10).

Anterior male legs without secondary sexual specializations.

Coxae of the eighth male legs separated by a distance greater than the transverse diameter of a leg socket.

Sphaeriodesmus bruesi (Chamberlin)

Cyclodesmus bruesi Chamberlin, Bull. Mus. Comp. Zoöl., **62**, p. 215, 1918.

Locality. Liguanea Plain, Jamaica.

The West Indian milliped fauna has few close connections with that of Central America, and none so direct or evident as that involving *Sphaeriodesmus pinetorum* and *S. bruesi*. The genus is typically Central American and the extenson of species into Cuba and Jamaica probably took place by migration from Yucatan across what is now the Yucatan Channel to Cuba, and thence to Jamaica, rather than by separate migrations from Yucatan to Cuba and Jamaica, as in the latter case a very much greater distance of what is now open water would need to have been traversed. Land connection between Yucatan and Cuba must have existed at one time, but the paucity of millipeds of Central American origin in Cuba would lead one to believe that such connection was maintained for a relatively short while.

Family CHELODESMIDAE

Caraibodesmus criniger new species

A male and female collected from Main Ridge, Blue Mts., Jamaica, 5000–7000 feet elevation, Aug. 17–19, 1934 by P. J. Darlington.

Diagnosis. The narrow first segment and the densely hairy dorsum unmistakably mark this species.

Description. Length of male 20 mm.; female somewhat longer and a little stouter; body strongly convex, tuberculate, and hairy; carinae rather small, projecting slightly from well below the level of the dorsum.

Color of the dorsum chestnut brown, except the outer posterior corners of the non-poriferous segments and the entire poriferous calluses of the other segments which are colorless; the lower sides and ventral surfaces are partly colorless; the legs colorless at base, distally light brown.

Head with fine erect setae scattered over it except on the posterior part of the vertex; vertex with a deep median furrow.

First segment nearly semi-circular, narrower than the head (Fig. 11); surface almost smooth, slightly irregular, shining, with a few scattered erect hairs; a single large hair projects outward from the margin a little in advance of each posterior corner; posterior corners right angled or even a little produced backward.

Second segment with a few broad, indistinct, tubercles scattered over the surface, each tubercle surmounted by an erect seta; outer margin of each carina with three distinct teeth in advance of the sharp, posteriorly produced, hind corner. Posterior margin of segment with an acute projecting tooth mesad of the base of the carina and a still smaller tooth mesad of it.

On the next two segments the setiferous tubercles become more distinct, and beginning with segment 5 they decrease in size but increase in numbers, so that on the posterior half of the body the dorsum is very densely and finely granular-tuberculate and is densely hispid. The segments are crossed transversely at middle by an indistinct, shallow, depression. The teeth of the posterior margin decrease in size after the first few segments and are not present on the last half dozen segments. Non-poriferous segments with the outer margin of the carinae toothed as in segment 2; other segments with two teeth in front of the pore callus; pores opening outward, the callus occupying half the margin of the carina; sides of the segments, below the carinae, smooth and shining; segments 2 to 8 or 9 with a granular ridge just above the legs; lateral carinae of segments 17, 18, and 19 decreasing in prominence, those of segment 19 inconspicuous and with the posterior corners scarcely produced. Last segment devoid of tubercles, in striking contrast to the preceding segments, and while no setae remain it appears that there had once been two transverse rows of two to four setae.

Legs with the two basal joints sparsely hairy, the third joint much more hairy, and the remaining joints still more densely hairy. Male legs without special modifications.

Gonopods as shown in figure 12.

Family CHYTODESMIDAE

The genus *Docodesmus* is more widely represented in the West Indies than any other of the order Merocheta, indeed in all the other orders it is equalled or surpassed in wide distribution by only three genera—*Rhinocricus*, *Orthoporus*, and *Siphonophora*. At present nine species of *Docodesmus* have been found in seven West Indian islands, beginning with Trinidad and extending northward to New Providence in the Bahamas, and westward to Cuba, where recently a species was found which is here described as new. Only one species has a range extending beyond the limits of the island where it was discovered, *D. trinidadensis* being found on the island of Tobago as well as adjacent Trinidad. At least one other species has been reported from northern South America and it appears that other species may have been described under other genera but a study of these forms is beyond the scope of the present paper.

Specimens of all the West Indian species, with one exception, have been examined by the writer, and a key for their separation and recognition has been prepared. Specimens of the genotype, *D. vincenti* (Pocock) were not seen but characters applying to no other species are given in the original description, and made inspection less necessary.

Key to the West Indian Species of Docodesmus

Body less than four times as long as broad; dorsum irregularly tuberculate and not divided into definite subquadrate areas..... *robustus* Loomis

Body four or five times as long as broad; dorsum divided into subquadrate areas; some tubercles, particularly the larger ones, in definite arrangement.....

Anterior raised rim of the posterior subsegments confined to the lateral carinae, not extending across the middle of the dorsum..... *semiseptus* Loomis

Anterior raised rim continuous across the lateral carinae and the middle of the dorsum.....

First segment with posterior margin almost straight for its entire length; quadrate areas of the dorsum each containing a single tubercle which is of large size..... *parvior* Chamberlin

First segment with the posterior margin transverse at middle and oblique on each side; quadrate areas of the dorsum with small tubercles in addition to the usual larger ones.....

Males with the sternum of segment 8 furnished with a pair of hairy tubercles in front; females with the ventral crest of segment 3 tri-lobed. . . . . *rincenti* (Pocock)

Males without hairy tubercles on the eighth sternum; females with the ventral crest of segment 3 bilobed or simple. . . . . .

Size small, from 5 to 7 mm.; dorsal tubercles strongly elevated. . . . . *sculpturatus* Loomis

Size larger, at least 10 mm. long; dorsal tubercles not strongly elevated

Size large, from 16 to 19 mm. long. . . . . *haitiensis* Chamberlin

Size intermediate, from 10 to 13 mm. long. . . . . .

Head with the vertex continuous with the front, scarcely inflated, finely granular, median furrow faint; last segment without a large truncated median lobe hiding the papillose apex from above. . . . . *cubensis* new species

Head with the vertex strongly inflated and separated from the front by a distinct channel, surface coarsely granular; last segment with a large truncated median lobe obscuring the papillose apex from above. . . . . .

Lateral carinae nearly horizontal; females with the ventral crest of segment 3 rising to an acute point at middle. . . . . *grenadae* Chamberlin

Lateral carinae obliquely descending; females with the ventral crest of segment 3 of uniform height for a considerable distance at middle. . . . . *trinidadensis* Chamberlin

Docodesmus cubensis new species

A complete female and another with head and first five segments missing found in bottle of millipeds collected with a Berlese funnel from "Forest floor," Soledad, Cuba, July 1932 by M. Bates and G. B. Fairchild.

Diagnosis. In the present genus a large median lobe and two large lateral lobes on each side of the last segment are found in one group of species, while the remaining species have little or no median lobe and small lateral lobes. *D. cubensis* falls within the latter group and may be distinguished from the other members by the pair of very large dorsal tubercles on the last segment, and the size and proportions of the body.

Description. Length 11 mm., width 2.5 mm. Body strongly convex, lateral carinae projecting outward a moderate distance and de-

scending obliquely throughout at about the same angle as those of *D. trinidadensis,* with which the species was directly compared.

Head with the median furrow of the vertex scarcely evident; surface on either side not much inflated and finely granular; vertex joining the front without interruption, the latter transversely rugose; clypeal area inflated, raised above the level of the front, smooth and shining.

First segment of the usual shape, the posterior margin oblique on each side; anterior marginal areas longer than those in *D. trinidadensis;* median surface divided into irregularly quadrate areas by faint depressed furrows, each area containing a rather large tubercle and several smaller ones.

Ensuing segments with the dorsum divided into quadrate areas, and sculptured in the same fashion as segment 1; posterior corners of the lateral carinae right angled to segment 10 or 11 (Fig. 13), behind which the corners gradually are acutely produced backward; anterior margin of the posterior subsegments with a fine, continuous or slightly undulated, raised rim extending across the dorsum to near the anterior corner of each carina; quadrate areas along the posterior margin of the segments about as broad as long; pores conspicuous and in normal arrangement.

Penultimate segment with the carinae moderately produced, reaching opposite the apex of the last segment, the posterior corners rather sharply rounded, not acutely angled; carinae widely separated, the margin between them with four slightly projecting scallops (Fig. 14).

Last segment small, the papillate apex exposed above, as there is no median lobe of the posterior margin; lateral lobes small; dorsum with two relatively large conic tubercles extending caudad nearly opposite the apex of the papillate terminal cone.

Preanal scale definitely triangular, the two setose tubercles small and quite close together.

Females with the transverse crest on the ventral side of segment 3 strongly elevated, scarcely rolled or bent backward, the median portion of uniform height for a long distance.

Docodesmus grenadae Chamberlin

Bull. Mus. Comp. Zoöl., **62**, p. 218–219, 1918.

Three paratype females of this species, from the Museum of Comparative Zoölogy, have been examined. The largest is 13 mm. long and not quite 3 mm. wide. The dorsum is strongly convex; the lateral

carinae project farther from the side of the body and are more horizontal than in *D. cubensis;* the outer margin of the carinae is rather short, the posterior corner rounded on the segments to near the back end of the body (Fig. 15). Raised rim along the anterior margin of the posterior subsegments thick and definitely interrupted or cut into erect crenations.

Penultimate and last segment shown in figure 16.

The last segment has two medium sized, subapical, dorsal tubercles which do not exceed the posterior margin; each lateral margin bears two lobes of which the posterior is much the largest; apical margin developed into a broad, truncated, lobe, beneath which the papillate apical cone is completely concealed from above.

Ventral crest of the third segment of the females rises gradually from each side to an acute apex at the middle.

Docodesmus trinidadensis and *D. grenadae* are very closely related species. *D. trinidadensis* has the vertex of the head slightly more coarsely granular and the lateral carinae descend more than in *D. grenadae,* which has the carinae nearly horizontal; the crest beneath segment 3 of the females is of even height throughout most of its length whereas in *D. grenadae* it rises from either side to an acute apex at the middle of the body.

From Pocock's description, it is evident that *D. vincenti* is closely related to the two preceding species, as the last segment has a large median lobe and the vertex of the head is roughly granular. However, the ventral crest of segment 3 of the females is said to be trilobed, a condition not found in any of the other species but possibly approached in *D. sculpturatus* which has a bilobed crest, each outer angle of the crest being elevated above the median portion. A further unique character of *D. vincenti* is the pair of hair-tipped tubercles on the sternum of segment 8 of the males, and there is a similar tubercle on each coxa of the front legs of this segment. No collection of *D. vincenti* has been reported since the original discovery of the species.

Family STIODESMIDAE

Heteropente planifrons Loomis

Bull. Mus. Comp. Zoöl., **75**, pp. 360–361, 1933.

A mature female 5.5 mm. long and 1 mm. wide, and a very immature specimen, collected with a Berlese funnel from "Forest floor," Soledad, Cuba, July 1932 by M. Bates and G. B. Fairchild.

The mature female is somewhat smaller than the male on which the genus and species was founded, and there are several other points of slight difference which possibly may be ascribed to variation within the species or to peculiarities of the sex. Suites of specimens containing both sexes should be collected at Jatibonico, the genotype locality, or at Soledad, to allow decision as to whether one or two species are involved. For the present it seems best to assume but one species.

The female has the two inner rows of tubercles raised into higher ridges on all segments than in the male, and these ridges, on segments 2 and 3, are even higher than on ensuing segments and the tubercles of which they are composed are fused together and indistinct; the anterior margin of the segments, between the two inner rows of tubercles, has two forwardly produced lobes separated by a deep sinus.

Family CYRTODESMIDAE Cook, 1896

Cyliocyrtus Cook

Proc. U. S. Nat. Mus., **21**, pp. 458–459, Nov. 19, 1898. Syn. *Trigonostylus* Brolemann, Ann. Soc. Ent. Fr., **67**, p. 273, Dec., 1898.

Comparison of the description and specimens of *Cyliocyrtus* with Brolemann's description of *Trigonostylus* shows that only one genus is involved, hence the older name stands. Furthermore, Brolemann was in error in using the new name, *Trigonostylus*, for a group of species which he divided into two subgenera, one of which was founded on a new species of *Crypturodesmus*, a genus proposed by Silvestri in 1897. The inclusion of this species as a subgeneric type should have forced the use of *Crypturodesmus* as the generic designation, with *Trigonostylus* ranking as only a subgenus, although it is evident that Brolemann's two subgenera should have been recognized as separate genera, for one falls in Silvestri's family *Crypturodesmidae*, and the other in Cook's *Cyrtodesmidae*.

The two species of *Cyliocyrtus* which Brolemann placed in the subgenus *Trigonostylus* appear to be distinct from *C. asper* (Peters) and *C. ocreatus* Loomis.

EXPLANATION OF PLATE

EXPLANATION OF PLATE

Siphonophora senaria Loomis

1. Head and first two segments, dorsal view.
2. Head and first two segments, lateral view.

Prostemmiulus alveatus Loomis

3. Gonopods, anterior view.
4. Gonopods, posterior view.

Rhinocricus cingendus Loomis

5. Gonopods, anterior view.
6. Inner gonopod.

Cyclodesmus irretitus Loomis

7. Gonopods.
8. Gonopod, outer lateral view.

Sphaeriodesmus pinetorum (Chamberlin)

9. First five segments, lateral view.
10. Last six segments, lateral view.

Caraibodesmus criniger Loomis

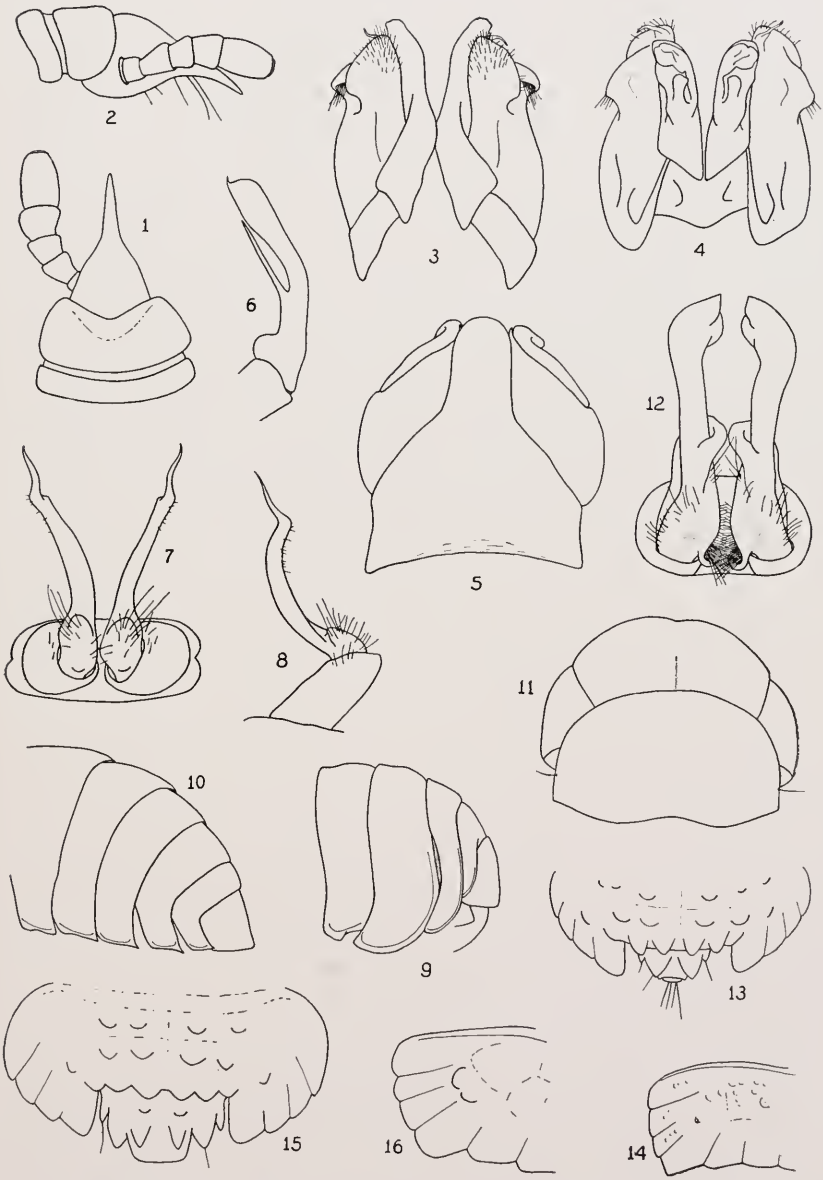
11. Head and first segment, dorsal view.
12. Gonopods.

Docodesmus cubensis Loomis

13. Keel of segment 10, dorsal view.
14. Segments 19 and 20, dorsal view.

Docodesmus grenadae Chamberlin

15. Keel of segment 10, dorsal view.
16. Segments 19 and 20, dorsal view.


2
1
3
4
6
5
12
7
8
11
10
9
13
15
16
14

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
VOL. LXXX, No. 4

A NEW TAPIR FROM THE LOWER MIOCENE OF WYOMING

BY ERICH MAREN SCHLAIKJER

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
JANUARY, 1937

No. 4. — *A New Tapir from the Lower Miocene of Wyoming*

By Erich Maren Schlaikjer

INTRODUCTION

Recently (1935, p. 153) the writer called attention to the discovery of a tapir in the lower Miocene beds of the Goshen Hole Area, Wyoming. The specimen has since been prepared for study and is found to represent a new genus and species, which forms a splendid intermediate stage between *Protapirus* of the Oligocene and the later tapirs. The discovery of this tapir is of singular importance since not more than three tapir teeth have been previously recorded from the Miocene (excepting the uppermost portion of the John Day) of North America.

The present paper is devoted to a description of this specimen together with a consideration of its relationships to other forms, and brief comments on the early ancestors of the true tapirs.

The specimen was collected approximately five hundred feet above the upper Oligocene (Brule) — lower Miocene (lower Harrison) contact, in beds which are composed of light to dark gray sands and sandstones with thin lenticular masses of clay, and which at certain levels are made up of more than fifty percent of plant remains. There is no extensive, clear demarcation between these beds and the upper levels of the lower Harrison. About four hundred feet above the Brule-lower Harrison contact, however, there is a fairly abrupt change to coarser sands and sandstones and to numerous but thin clay beds. This zone probably marks the change from lower to upper Harrison. A hundred feet higher at exactly the same level of the tapir, specimens of *Parahippus wyomingensis, Merychyus minimus, Oxydactylus* and *Palaeocastor* were collected. The nearest affinities of these forms occur in the upper Harrison of Northwestern Nebraska. For these stratigraphic and palæontologic reasons, the writer considers, tentatively at least, this level as belonging to the lower part of the upper Harrison.

Order PERISSODACTYLA

Superfamily TAPIROIDEA

Family TAPIRIDAE

Miotapirus harrisonensis gen. et sp. nov.

Type. Anterior portion of the skull and jaws with complete dentition and a considerable portion of the skeleton. M. C. Z. No. 2,949. Collected by Erich M. Schlaikjer, 1934.

Horizon and locality. Lower Miocene. Lower part of the upper Harrison formation, approximately 500 feet above the Brule-lower Harrison contact. S.W.¼. Sec.3. T.24N. R.65W. Goshen County, Wyoming.

Generic and specific characters. Superior premolar length greater than superior molar length. Protocone and hypocone on the premolars distinctly separated. P^4 larger than M^1. Internal cingula on premolars diminished. Nasals reduced and nasal excavation about as in *Tapirus roulini*. Inferior premolars with well developed hypolophid. I_1 larger than I_2, and I_3 diminutive. P_2 proportionately short (anteroposteriorly). M_1 smaller than P_4. Symphysis constricted but massive. Lunar with anterior magnum facet. Astragalus with small anterior cuboid facet. Ectocuneiform in contact with metatarsal IV.

DESCRIPTION

Upper Dentition. The incisors are large. I^2 is slightly larger than I^1 and has the cingule somewhat more emphasized. I^3 is the largest, and is taller crowned. On its posterior side there is a worn surface which is the result of occlusion with the inferior canine. The superior canine is small and peg-like. It is separated from I^3 by a short diastema and is situated immediately behind the premaxillary-maxillary suture. There is a forty-eight millimeter diastema between the canine and P^1.

In many characters of the cheek teeth, *Miotapirus harrisonensis* is decidedly in advance over *Protapirus obliquidens* (the most advanced of the known *Protapirus* species). This is particularly true of the premolars. The more important of these characters are as follows:

1. A distinct separation of the protocone and hypocone in the premolars.
2. Loss of a distinct metaconule and the development of a metaloph on P^{2-4}.
3. Absence of the internal cingulum on P^{3-4}.
4. P^1 with a large hypocone and an incipient protocone. Also, the paracone is enlarged but the metacone is still small.
5. P^2 proportionately wider across the anterior, which is mainly the result of the enlargement of the protocone. In addition, there is almost a complete protoloph.
6. The premolar series is of greater length than the molar series.

In all of these characters, *Miotapirus harrisonensis* is more primitive than *Tapirus* and the other later genera.

The Skull. The entire postorbital region of the skull is missing. The anterior portion is excellently preserved. In the posterior position of the orbit, *Miotapirus* is almost as primitive as *Protapirus validus.* It is much more advanced, however, than that species in the following characters. 1. The presence of an excavation on the postero-external corner of the nasal. 2. A greater reduction of the nasals. 3. A proportionate increase of skull depth. 4. The proportionately wide dimension across the jugals. 5. The abrupt constriction across the maxillaries immediately in front of the first premolar. 6. A proportionate elongation of the skull anterior to P^1. 7. A general increase in size.

Only a small part of the lachrymal is preserved at the antero-inferior margin, where it is in contact with the jugal and the maxillary. The preserved part shows that it was mostly restricted to the margin of the orbit. The lachrymal foramen is large.

The jugal is rather extensive and massive. The zygomatic portion is insufficiently preserved to determine if it bore a post-orbital process.

Above the first premolar, the maxillary is convex dorsoventrally. This convexity continues posteriorly just above the remainder of the cheek teeth. About half way up on the face there is a shallow groove leading into the rather large infraorbital foramen, which is situated above the center of the fourth premolar. On the anterior margin of the ascending wing of the maxillary, there is a shallow oblique depression leading from the nasal cavity into a groove on the side of the maxillary just below the naso-maxillary suture. The external margin of this groove shows that that portion of the maxillary was suturally united with an antero-inferior projection of the frontal. The maxillary groove is confluent with the dorso-external excavation on the nasal. In *Miotapirus* the narial diverticula, therefore, were developed approximately as they are in the recent *Tapirus roulini.*

The nasals are not coössified. They are more reduced than in *Protapirus validus.* In this character, and in their general form and development of the excavations, they are nearer to those of *Tapirus.*

The premaxillaries are elongated, expanded and are relatively shallow. They are not coössified. The alveolar portion is large and heavy. It is most widely expanded across the alveoli of the third incisors. The posterior portion is narrow and pointed. It extends posteriorly, overlapping the maxillary, to a point above the second premolar. Ventrally the premaxillaries do not extend back behind a line opposite the centers of the canines.

The palate is sharply concave transversely and gently concave antero-posteriorly. It is constricted anteriorly and somewhat broadly open posteriorly. The palatine fissure is large. It extends from immediately in front of the canine to the front of the first premolar. The palatine grooves are large and deep, and the anterior palatine foramina are large. They are situated opposite the protocones of the first molars. The posterior palatine foramina are rather small and are opposite the protocones of the second molars. Only a small anterior portion of the right palatine is preserved. Its postero-mesial margin shows that the anterior border of the internal narial opening occupied a position opposite the center of the second molar.

The nasal cavity is very large. Grooves on the maxillary part of the floor, as well as the overhanging portions of the ascending wings of the maxillaries, indicate that the turbinals were large and that they extended far forward, as in the recent tapir.

Measurements of the skull

	mm.
Interior front of orbit to front of I^1 alveolus	148.0
Greatest length of nasals	91.3
Width across canine alveoli (exterior)	44.2
Width across third incisors on alveoli (external)	44.0
Length of tooth row, anterior of I^1 to posterior of M^3 on alveoli	182.8
Greatest length of P^1–M^3	113.2
Greatest length of P^1–P^4	60.2
Greatest length of M^1–M^3	54.7
Width of I^1 crown	11.8
Width of I^2 crown	12.5
Distance from posterior of canine to anterior of P^1 on alveoli	27.4
Greatest length of P^1	14.1
Greatest width of P^1	13.3
Greatest length of P^4	16.5
Greatest width of P^4	20.5
Greatest length of M^1	16.3
Greatest width of M^1	20.3
Greatest length of M^3	19.0
Greatest width of M^3	23.5

Lower Dentition. The incisors are procumbent. I_1 is the largest. I_3 is much reduced, — being less than half the size of I_1. The crowns

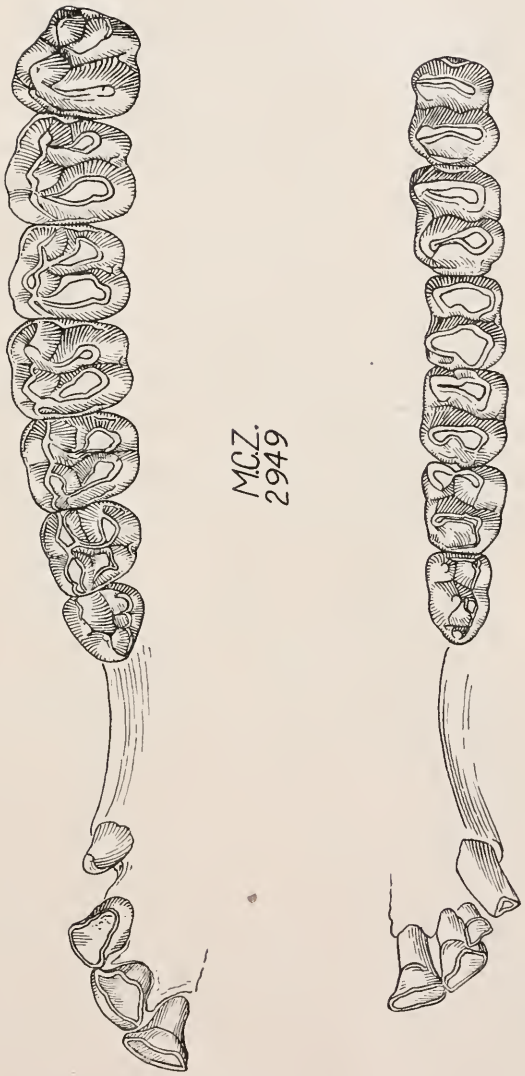


Fig. 1. *Miotapirus harrisonensis*. Type. Upper and lower dentition; Three fourths natural size. Drawn by Helen Ziska.

of the incisors, especially of I_1 and I_2, are tall and there is an internal basal heel developed on each. The canine is set close to I_3. It is large, circular in outline and long-crowned, the anterior surface of which has been worn flat as the result of occlusion with the superior third incisor.

The second premolar is separated from the canine by a long diastema. The paraconid on that tooth is considerably reduced, although it is distinct. The hypoconid and endoconid have almost united to form a posterior cross crest. There is a minute posterior cingulum. An anterior and a posterior cingulum are present on each of the remaining teeth. These cingula are best developed on the second and third molars. The posterior one is always the larger. A posterior cross crest is present on P_3 and on P_4. P_4 is larger than M_1. M_2 and M_3 are subequal in size.

The Mandible. The ascending rami and the posterior part of the right ramus are missing. The symphysis is long, deep and heavily constructed. There is a long diastema between the canine and P_2. The supra-symphyseal depression and groove are as pronounced as in the recent tapir. The mental foramen is small and is located half way between P_2 and the canine and approximately two-fifths of the way down on the jaw. The inferior border of the ramus is gently convex antero-posteriorly and is bi-convex in vertical cross section.

Measurement of the jaw

	mm.
Distance from anterior of canine to posterior of M_1 on alveoli	151.3
Length of the diastema	37.8
Width across the canines on the alveoli (exterior)	38.0
Length of P_2 to M_3	103.2
Length of P_2 to P_4	47.0
Length of M_1 to M_3	56.1
Width of I_1 crown	10.5
Width of I_2 crown	9.6
Width of I_3 crown	6.8
Antero-posterior diameter of canine at base of crown	9.0
Length of P_2	16.0
Greatest width of P_2	11.6
Length of P_4	16.1
Greatest width of P_4	14.7
Length of M_1	16.3
Greatest width of M^4	13.4

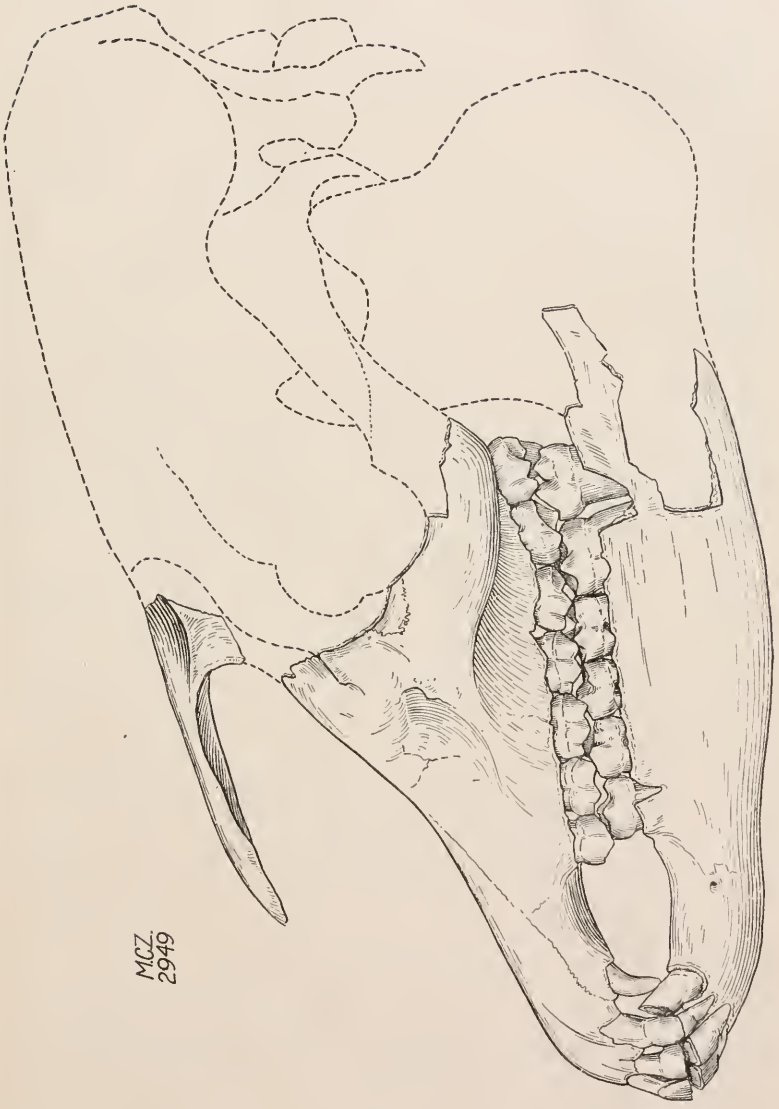


Fig. 2. *Miotapirus harrisonensis*. Type. Lateral view of the skull. One half natural size. Drawn by Helen Ziska.

The front limb. Both scapulæ are missing. With this exception, however, the preserved limb portions are sufficient to enable a reconstruction of most of the limb elements.

A large section of the proximal end of the shaft of the left humerus and the distal end of the right humerus are known. The head and lateral tuberosity have been lost, but the section present shows the development of the deltoid process and the general form of the shaft is about as in *Tapirus*, except of somewhat smaller size. The medial condyle is approximately twice as wide as the lateral condyle. The ridge separating the two is large and prominent. On the front of the humerus just above the condyles is the extensive coronoid fossa. Its walls, as well as the area immediately external to it, are very roughened. The extent of this area of attachment shows that the extensor digitalis communis and the extensor carpi radialis muscles were well developed. The wall between the coronoid fossa and the deep, rounded olecranon fossa is only slightly perforated. In some of the modern tapirs this wall is entirely absent, while in others its perforation, if present, is no larger than in *Miotapirus*. The distal end of the humerus is very similar to that of *Tapirus* in nearly every respect. The only observable difference is the proportionately somewhat smaller transverse dimension.

The left ulna and radius are complete and the right are partially preserved. Compared with *Tapirus*, the following differences occur:

1. The shaft of the radius is proportionately broader.
2. The proximal and distal extremities of the radius are not as expanded.
3. The central portion of the ulna shaft is united with the radius, leaving two separated interosseous spaces; whereas in the recent tapir, there is one continuous interosseous space extending throughout the entire length of the shaft.
4. On the front of the ulna, the area for the origin of the extensor carpi obliquus (abductor pollicis longus) is neither as deep nor as extensive.

In all other features the two are very much alike.

Of the carpus only the lunar, cuneiform and pisiform are known. In general form the lunar is keystone-shaped. Ventro-laterally it is firmly in contact with the cuneiform. It also possesses a fairly large anterior facet for articulation with the magnum. This facet is about as large as in the recent tapir (as pointed out by Mr. Earle, — 1893, p. 118, this anterior articulation between the lunar and magnum is frequently absent). The cuneiform displays advancement over that of *Protapirus* principally in that it is proportionately wider and deeper.

Its ventro-anterior lunar facet is somewhat smaller than in *Tapirus*, otherwise it is identical with that of the recent form. Likewise, the pisiform shows no difference from the pisiform of a recent tapir. The scaphoid is not present but from its articular surfaces on the lunar, it can be inferred that this carpal was perhaps not appreciably different from that in the later tapirs.

Nearly all of the metacarpal bones are complete either in one foot or the other. The rather large posterior facet on the proximal end of metacarpal II indicates that the trapezium was quite large, — but perhaps less so than in *Protapirus*. The characters of the metacarpus and phalanges, showing advancement over that genus, are as follows:

1. Metacarpal II is proportionately shorter, and its proximal extremity relatively more expanded.
2. Metacarpal III is proportionately larger, and the magnum facet is considerably better developed.
3. The first and second phalanges of the third digit are much shorter and wider. (The first phalanx of the left second digit is unusually large, for it shows, as well as the distal end of metacarpal II, a marked pathological abnormality.)

In these characters *Miotapirus* is intermediate between *Protapirus* and *Tapirus*, although somewhat closer to the latter.

The hind limb. The greater portion of the right hind foot is all that remains of the hind limbs. The foot is remarkably like that of *Tapirus*, and is different only in minor primitive characters. The sustentaculum on the calcaneum does not project inwardly quite so far, and the neck of the astragalus is somewhat less broadened. The cuboid is missing but it probably was not as wide, since the superior antero-external margin of the navicular is not as overhanging and the cuboid facet on the astragalus is rather less extensive. Also, the ectocuneiform is slightly deeper and narrower. It has a small metatarsal IV facet. In commenting on the osteology of recent tapirs, Mr. Charles Earle (1893, p. 118) stated, "in the Malayan species both the lateral metatarsals articulate with the ectocuneiform, whereas in the Brazilian form only the internal metatarsal touches this podial element." In general this is true, although I have found a few cases where in the American form there is a slight posterior articulation between these two elements. In this particular character *Miotapirus* is, however, decidedly closer to the Indian species.

Another character of the pes, which shows that *Miotapirus* is not far removed from *Tapirus*, is the presence of a small facet on the posterior projection of the proximal extremity of metatarsal III. This facet is

just above the rough area for attachment of the suspensory ligament and is the articulatory surface for the small and nodular-like metatarsal I. Part of the facet is broken away, but it is sufficiently represented to show that it was perhaps smaller than in *Tapirus*. The presence of metatarsal I and its articulation with the posterior of metatarsal III in *Tapirus* has been described and figured by de Blainville (1846, p. 19, pl. 4). Although the hind foot of *Protapirus* is not completely known, metatarsal I was undoubtedly present. Whether or not it had as yet assumed its contact with metatarsal III remains problematical. While studying the *Heptodon* material in the American Museum Collection, I discovered that in one specimen (Amer. Mus. No. 294, referred to *H. calciculus*), of which the hind foot is known, there is a fairly large facet on the postero-inferior surface of the large endocuneiform. Metatarsal I was, therefore, present in the foot of that genus. The fore and aft position of the endocuneiform, however, shows that it probably was not in contact with metatarsal III (the posterior part of the proximal end of the latter is missing).

Other skeletal parts. The remaining portion of the skeleton consists of cervicals 5, 6 and 7, a part of the first dorsal and several rib fragments. These elements present no particularly distinctive features other than that the cervical vertebrae are proportionately somewhat longer than in the recent tapir.

Measurements of the skeleton

	mm.
Width of distal end of humerus on lateral ligament depressions	54.2
Length of radius on inner side	175.8
Greatest width of proximal end of radius	46.1
Narrowest width of radius shaft	22.6
Greatest height of lunar	25.7
Greatest length of metacarpal III	108.5
Greatest width of proximal end of metacarpal III	24.1
Greatest length of metacarpal II	95.4
Greatest length (dorsal) of first phalanx, 3rd digit	26.4
Width of proximal end of first phalanx, 3rd digit	25.8
Length of the calcaneum	84.1
Width of distal end of astragalus	34.9
Greatest width of the ectocuneiform	23.6
Greatest height of the ectocuneiform	12.9
Greatest length of metatarsal III	118.8
Greatest width of distal end of metatarsal III	27.6
Greatest length of metatarsal II	116.4

Fig. 3. *Miotapirus harrisonensis.* Type. Anterior view of the right pes. One half natural size. Drawn by Helen Ziska.

AFFINITIES

Various tapiroid forms from the Eocene have been proposed as the ancestors of the true tapirs, and a considerable discussion regarding which genus should occupy that ancestral position can be found in the literature covering the subject. In 1893 Dr. Wortman and Mr. Earle (pp. 172–173) concluded their consideration of the phylogeny of the tapirs by stating:

"1. We consider the genus *Systemodon* [= *Homogalax*] as standing in ancestral relation to the Tapiridæ.
2. *Isectolophus latidens* is probably in the line leading to the true tapirs.
3. If further discovery shows that *I. annectens* has both the last two premolars as complex as the true molars, it must be removed from the main tapir line."

After a brief discussion of *Heptodon* and the then very inadequately known genus *Helaletes*, they give the following statement (p. 180), "In fact all the known species of both *Systemodon* [= *Homogalax*] and *Heptodon* are extremely slender forms as compared with their supposed Miocene [= Oligocene] successors, and if we derive the true tapirs and pseudo-tapirs from any of the known species of either of these genera we must suppose a considerable modification of their foot structure to reach the condition found in their Miocene [= Oligocene] relatives. The dentition of those early Wasatch and Wind River tapiroids, however, is well adapted for further evolution into later Miocene types, but in their foot structure we find it otherwise."

Mr. Hatcher (1896, pp. 177–178) concurs with the opinion of Dr. Wortman and Mr. Earle that the true tapirs were derived from *Homogalax* through *Isectolophus*. He points out, however, that the external position of the metacone on the superior molars of *Isectolophus* would require an internal migration of that cone to achieve the *Protapirus* condition and then that cone would again have to migrate outward to assume the position it has in the molars of the recent tapirs. Mr. Peterson (1919, pp. 124–126) felt that a belief in such oscillation is unwarranted, and demonstrated, with the aid of additional and more complete material, that *Isectolophus* has a distinct protocone and hypocone on P^3. This character is also found in *Parisectolophus* and *Helaletes*, although in the latter genus there is but the slightest separation of the two cusps. Because of this advanced development of P^3 it is improbable that any of these three genera, as is suggested by Mr.

Peterson, could be ancestral to *Protapirus*, the primitive species of which have a single undivided cusp (deuterocone) on each of the superior premolars. Mr. Peterson concluded (p. 126) that, "The true Eocene ancestors of the Oligocene and recent tapirs cannot logically be said to be represented by the remains heretofore found in the Eocene of North America."

In his redefinition of the genus *Helaletes* Marsh, Dr. Troxell[1] makes the following statement (1922, p. 370): "A relationship to the tapir is indicated by nearly all the important characters of *Helaletes:* the position of the antorbital foramen, the rising of the sagittal crest, the trend toward molariformity in the premolars, the low maxillaries, and especially the presence of a pit in front of the orbit which may have given rise to the receded nasal aperture of the modern animal." From this, one would infer that Dr. Troxell feels "the trend toward molariformity in the premolars" is a necessary requisite for the Eocene ancestor (which he seems to regard as *Helaletes*) of the later true tapirs. Apparently Dr. Troxell does not take cognizance of the fact that in *Protapirus simplex,* the species found earliest in the Oligocene, there is no indication whatever of a separation of the single internal cusp of the superior premolars into two distinct cusps, — a protocone and a hypocone.

Dr. Pilgrim, in his memoir on the Eocene perissodactyls of Burma (1925), seems to favor the earlier view of Dr. Wortman, Mr. Earle, and Mr. Hatcher that *Homogalax* and *Isectolophus* are in the direct ancestry of the later true tapirs. He specifically states (p. 24) his acceptance of Mr. Hatcher's observation that the internal premolar cusp in *Isectolophus* is undivided. It is apparent that Dr. Pilgrim was not familiar with Mr. Peterson's 1919 paper in which the dentition of that genus is excellently figured. He quite rightfully concludes that his new genus *Indolphus* is in some ways intermediate between *Homogalax* and *Isectolophus,* although he does not definitely propose it as an ancestor to the true tapirs. P^4 has a faint beginning of a division of the internal cusp. The absence of a posterior crest on that tooth, however, as pointed out by Dr. Pilgrim, is a condition even more primitive than

[1] One of the reasons Dr. Troxell gives for his redescription of *Helaletes* is (p. 365), "because it is very much misunderstood, and has no published drawings." He makes no mention of Mr. Peterson's paper, which appeared three years earlier, and in which the Yale type of *H. boops* was fully described and figured. I call attention to this not because of Dr. Troxell's oversight, but because he and Mr. Peterson do not agree as to the presence or absence of a second internal cusp on the premolars of the type *H. boops.* Mr. Peterson says (p. 106) that P^3, "appears to have a slight indication of two internal tubercles on the worn surface." Dr. Troxell says, however, (p. 368) "As constrasted with *Helaletes nanus*" (in which species two internal tubercles are but slightly developed) "*H. boops*, the genoholotype, lacks distinctly separated cones on the inner side of the premolars."

that found in any of the known Eocene tapiroids. Its nearest approach is to be found in *Helaletes*. Other characters in which *Indolphus* approximates *Helaletes* rather than *Homogalax* are, the general form of P^3, and the mergence of the posterior cingulum with the hypocone. The latter condition is also characteristic of the molars in *Heptodon*.

I am inclined to agree with Mr. Peterson that *Isectolophus*, *Parisectolophus* and *Helaletes* are already too specialized in the dentition, particularly in the superior premolars, to be regarded as ancestral to the later true tapirs. *Indolphus*, although very imperfectly known, seems to show those same specializations, especially in the slight division of the internal cusp of P^4, and on the basis of this should, for the present be eliminated from the true tapir ancestry. It would seem that *Homogalax* is also too specialized; and, that it is already off on a side line, which probably led to *Isectolophus*, is shown by characters of the teeth such as the following:

1. The great obliquity of the protoloph and metaloph.
2. The posterior and internal cingula of the molars confluent, or nearly so.
3. The large parastyle on the premolars.
4. The quadrangular form of P^3 with its anteriorly located deuterocone.
5. The fairly simple construction of P^1 and P^2.
6. The large hypoconulid on M_3.

In *Heptodon*, however, the protoloph and metaloph are not as oblique; the posterior cingulum is confluent with the hypocone; the parastyle on the premolars is reduced; P^3 is triangular in outline; P^2 has the same general form as P^3 and P^4; and, the hypoconulid of M^3 is somewhat reduced. In all of these characters, as well as in the general proportions of the teeth, *Heptodon* is decidedly tapir-like. In Figure 4A is shown the premolar-molar series of a specimen in the American Museum Collection (No. 14,884). This specimen, probably referable to the species *Heptodon ventorum*, does not possess a single character which would eliminate it as directly ancestral to *Protapirus*. None of the skeletal parts of this specimen are preserved, but other specimens in the American Museum Collection (e.g. No. 294) and in the collection at the Harvard Museum of Comparative Zoölogy (including a fine skeleton M. C. Z. No. 17,670) show that throughout the skeleton, and especially in limb structure, *Heptodon* likewise displays nearly every feature one would expect to find in an early Eocene ancestor of the true tapirs. As mentioned above, Dr. Wortman and Mr. Earle remarked that the

feet of *Heptodon* are slender, and that for this genus to be ancestral to *Protapirus* would necessitate considerable change in foot structure. It is true that the phalanges of *Heptodon* are proportionately long and slender, and that the ungual phalanges are slightly cleft on their antero-dorsal surfaces. Also, the lunar is less firmly in contact with the unciform, and the first metatarsal is somewhat larger than in the later tapirs. These are primitive characters, however — characters which are diagnostic of an early perissodactyl. The change required in foot structure from *Heptodon* of the lower Eocene to *Protapirus* of the Oligocene is certainly not as great as that which took place from *Lambdotherium* to *Brontotherium* among the titanotheres, or no greater than that from *Eohippus* to *Mesohippus* among the horses.

From the above cited facts, based on the known material, it seems logical to regard *Heptodon* as the direct ancestor of *Protapirus*.

That *Protapirus* is the direct Oligocene ancestor of the later tapirs has not been seriously questioned by anyone.[1] The discovery of *Miotapirus* contributes a fuller substantiation of this, since in many important characters of the skull and dentition alone, it displays an admirable transition from *Protapirus* to *Tapirus*. These characters are as follows:

1. The reduction of the nasals.
2. The presence of an excavation on the postero-external corner of the nasal.
3. A proportionate increase in skull depth.
4. A proportionate increase in the width across the jugals.
5. An abrupt constriction across the maxillaries immediately in front of P^1.
6. A proportionate elongation of the skull anterior to P^1.
7. Heavy construction of the symphysis as well as of the jaw in general.
8. The length of the superior premolar series exceeds that of the molars.
9. There is no distinct metaconule on P^{2-4} and the metaloph is fairly well developed on those teeth.
10. Absence of the internal cingulum on P^{3-4}.
11. P^1 has a large hypocone and an incipient protocone. Also, the paracone is enlarged but the metacone is still small.

[1] Samuel Schaub (1928, p. 14) believes that the reference of the American species to this European genus should remain questionable, regardless of the close similarity in dentition, until the skull of *Protapirus priscus* Filhol, from the Phosphorite beds, is known.

12. Increase of diameter across the anterior of P^2, and the occurrence of an almost complete protoloph.
13. Proportionately large size of I_1 and small size of I_3.
14. Relative increase in size of the inferior canines.
15. Reduction of the paraconid of P_2
16. Absence of the paraconid on P_3. (In *P. obliquidens* it is almost as large as in P_2.)
17. Hypoconid and endoconid unite to form a cross crest in P_3 and P_4, and nearly so in P_2. These hypolophids are not developed in *Protapirus*.
18. P_4 is larger than M_1.

In so far as the post-cranial skeletons of *Protapirus* and *Miotapirus* are known, the same holds true. Every important character in the recent tapir is already established in *Miotapirus*.

In 1893 Dr. Wortman and Mr. Earle described two new species of *Protapirus* from the Oligocene of South Dakota; one, *P. simplex* from the oreodont beds or middle Oligocene; and the other, *P. obliquidens* from the *Protoceras* beds or upper Oligocene. This was the first record made of this European genus in North America. In 1896 Mr. Hatcher described a third species, *P. validus*, which he rightfully regarded as intermediate between *P. simplex* and *P. obliquidens*. He stressed particularly the molarization of the premolars. In Figure 4 the upper dentition of these three species, together with that of *Miotapirus* and *Tapirus*, are shown. These drawings illustrate how from the simple superior premolars (P^{2-4}) of *P. simplex*, with their single internal cones and rudimentary cross crests, to the molariform premolars of *Miotapirus* and *Tapirus*, there is a gradual development of the protocone and hypocone, a gradual separation of these cusps, and the formation of cross crests. It is of interest to note that the protocone and hypocone of the premolars of *Miotapirus* and the later tapirs seem to have been differently developed in the different premolars. In P^2, and possibly in P^1, it seems that the original single internal cusp shifted forward to form the protocone, and a distinct cusp, the hypocone, appeared at the postero-internal corner of the tooth. While it is possible that the protocone and hypocone in P^3 and P^4 were similarly derived, it is probable that in these teeth, the protocone and hypocone had their origin in a separation of the original internal cusp. Another important dental change, not previously observed, is that the superior premolar series in *Protapirus* is not as long as the molar series, whereas in *Miotapirus* and the later tapirs the premolar length exceeds that of the molars.

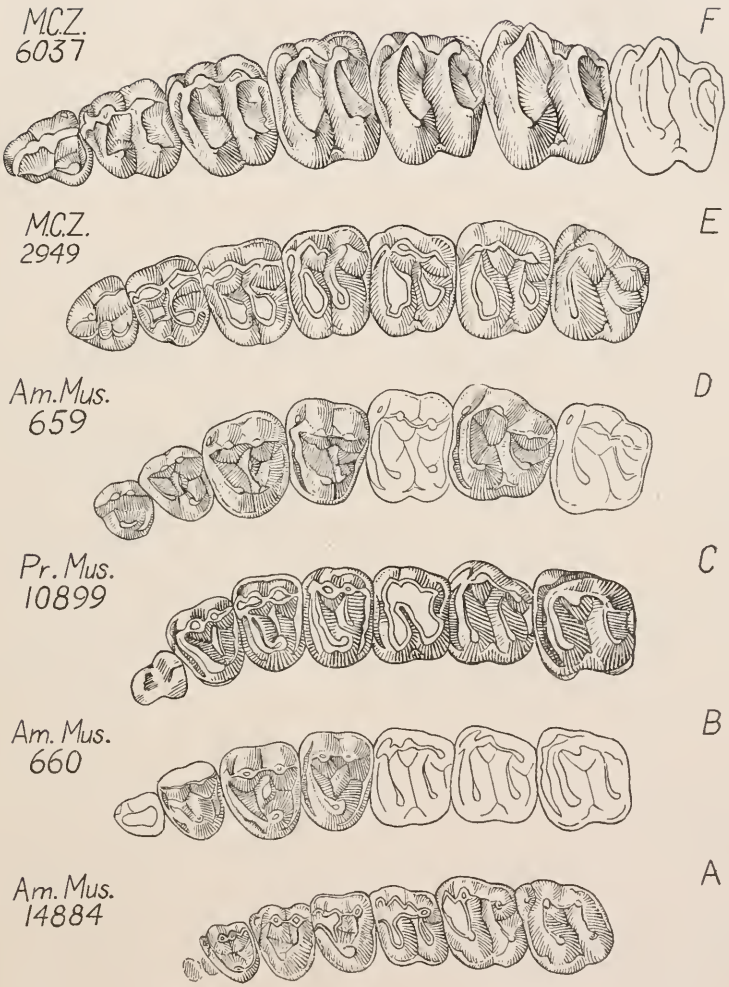


Fig. 4. Comparative drawings of left upper cheek teeth. A, *Heptodon ventorum*. B, *Protapirus simplex*, type. C, *P. validus*, type (after Hatcher). D, *P. obliquidens*, type. E, *Miotapirus harrisonensis*, type. F, *Tapirus roulini*. A, natural size. B-F, two-thirds natural size. Drawn by Helen Ziska.

Protapirus robustus was described in 1901 by the late Professor W. J. Sinclair. The specimen (No. M 934, Univ. of Cal. Pal. Mus.) is that of a pair of incomplete lower jaws and a few other skeletal parts. Its geological level is the *Promerycochœrus* beds, upper John Day of Oregon. Perhaps the most unusual character of this species is its size. It is as large as the existing American *Tapirus*. The absence of posterior cross crests on the premolars, the small canine (as is shown by the alveolus) and the subequal size of the first and second incisors are characters which certainly place this species in *Protapirus*. I regard *P. robustus* as representing a specialized line tending towards gigantism. In Figure 5 I have shown it as coming directly from *P. simplex*, rather than from *P. validus* as suggested by Professor Sinclair. My only reason for this is that in the proportions of the inferior premolars it seems somewhat closer to that species. Then too, when the upper teeth are known, *P. robustus* may prove to have the metaloph undeveloped and a single internal cusp instead of a protocone and a hypocone on the premolars.

Another Oligocene genus, described by Professor Marsh (1894), is *Tanyops undans*. This is the only species recorded. It is based on a pair of lower jaws collected from "the *Miohippus* beds of South Dakota," — which means the upper Oligocene or possibly the lowermost Miocene. The specimen has not been figured, but from Professor Marsh's very brief description it would seem to be about the size of *Protapirus obliquidens*. The small canine also indicates a close affinity with that species. The only character, cited by Professor Marsh, which is possibly of generic value is the molar-like P_4. In the described species of *Protapirus* there is never a posterior cross crest in any of the three inferior premolars, whereas in *Miotapirus* this cross crest is complete in P_3 and P_4, and nearly so in P_2. Whether or not this single character is sufficient for regarding *Tanyops undans* as a valid genus is debatable. It may, however, possess other distinctive characters. I have not seen the specimen. On the other hand, when more complete material is discovered, it may prove to be only a more advanced species of *Protapirus*. Nevertheless, for the present I am considering it as valid. In Figure 5 it is given a position intermediate between *P. obliquidens* and *Miotapirus*, which, on the basis of its known characters it certainly should hold.

Aside from *Miotapirus*, the only other Miocene tapir known from North America is *Tapiravus* Marsh. The genoholotype is a single upper tooth, either P^4 or M^1, from "the Miocene marl of Cumberland County, New Jersey" (1871, p. 10). The specimen was first described by Professor Marsh as *Lophiodon validus*, but in 1877 was placed by

him in a new genus which he called *Tapiravus*. In the same paper, he described a second species, *T. rarus*,[1] from the "Lower Pliocene east of the Rocky Mountains" (p. 252), also based on an upper molar tooth. On the basis of the known material, which is very scanty, *Tapiravus* differs from *Tapirus* only in its considerably smaller size. It cannot, therefore, be confused with *Miotapirus*. It is a very advanced form and probably represents a dwarf line in tapir evolution. The advanced stage of *T. validus* would seem to indicate that the beds in which it was found are either uppermost Miocene or lower Pliocene in age.

CONCLUSIONS

1. *Isectolophus*, *Parisectolophus*, *Helaletes*, and *Indolophus* are too specialized to be ancestral to the later true tapirs.

2. *Homogalax*, of the lower Eocene, is also too specialized, and is already off on a side line which probably led to *Isectolophus*.

3. *Heptodon*, in so far as it is known, possesses no important characters which would eliminate it as the direct ancestor of *Protapirus*.

4. *Miotapirus* forms an excellent intermediate stage between *Protapirus* and *Tapirus*.

5. *Protapirus simplex* of the middle Oligocene, and *P. validus* and *P. obliquidens* of the upper Oligocene form an ideal phylogenetic line leading to *Miotapirus*.

6. *Protapirus robustus* of the upper John Day seems to represent a specialized line, tending towards gigantism, that probably came directly from *P. simplex*.

7. *Tanyops undans* of the upper Oligocene is for the present considered as valid, although additional material may demonstrate that it is only an advanced species of *Protapirus*. In any case, it probably should be regarded as intermediate between *P. obliquidens* and *Miotapirus*.

8. *Tapiravus* from the lower Pliocene, or uppermost Miocene is distinct from the recent tapir only in its considerably smaller size. It probably represents a dwarf line in tapir evolution.

[1] The heading of Professor Marsh's description (1877, p. 252) is "*Tapiravus rarus* gen. et sp. nov." From this it may be inferred that *T. rarus* is the genoholotype. In the text, however, he states, "The type species is *T. validus* Marsh (*Lophiodon validus*) from the Miocene of New Jersey." Even though *T. rarus* is mentioned first in the article, I consider *T. validus* as the genoholotype since it is specifically designated as such.

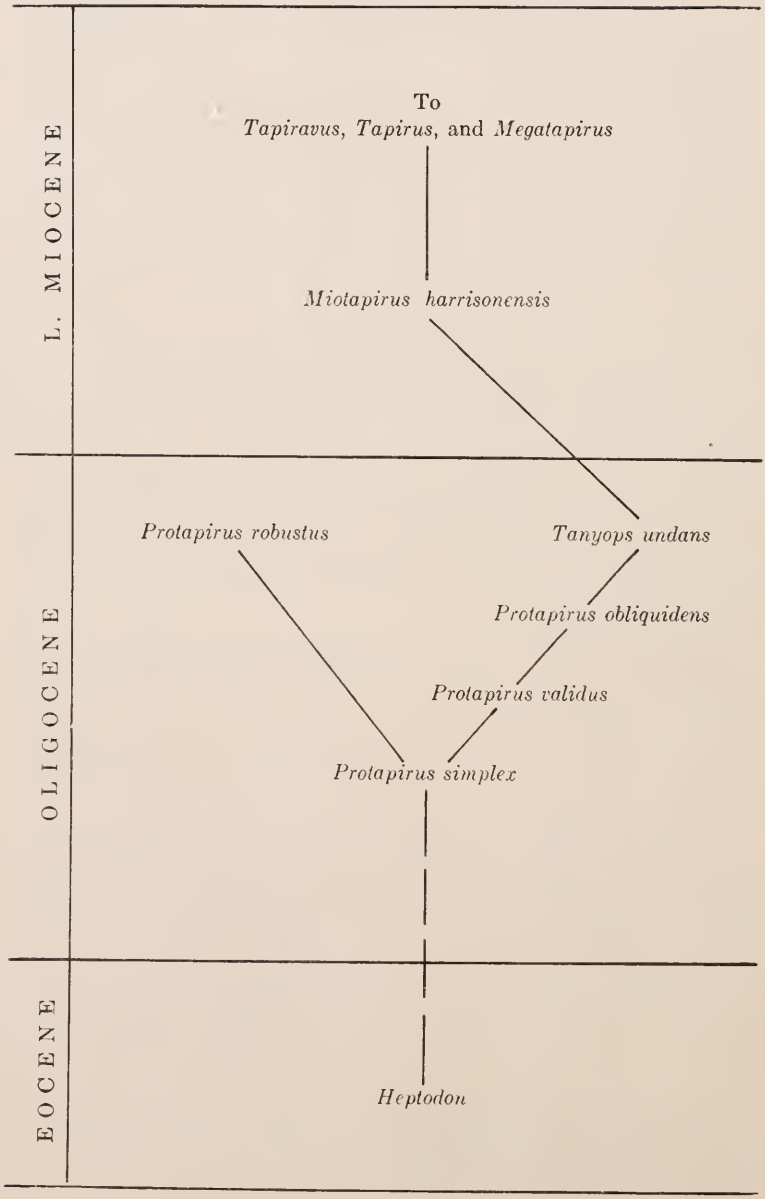


Fig. 5. Diagram illustrating the affinities of the Oligocene and Miocene true tapirs of North America. Schlaikjer, 1935.

BIBLIOGRAPHY

Blainville, H. M. D. de,
1846. Osteographie . . . des mammiferes. Paris. Tome 4, Sec. Z, G. *Tapirus*, pp. 1–52, pls. 1–6.

Earle, C.
1893. Some points in the comparative osteology of the tapir. Science, **21**, p. 118.

Hatcher, J. B.
1896. Recent and fossil tapirs. Amer. Jour. Sci., ser. 4, **1**, pp. 161–180, pls. 2–5, 2 text figures.

Marsh, O. C.
1871. Note on *Lophiodon* from the Miocene of New Jersey. Proc. Acad. Nat. Sci. Phil., **23**, pp. 9–10.
1877. Notice of some new vertebrate fossils. Amer. Jour. Sci., **14**, pp. 249–256.

Peterson, O. A.
1919. Report on the material discovered in the upper Eocene of the Uinta Rasin by Earl Douglass in the years 1908–1909, and by O. A. Peterson in 1912. Ann. Carn. Mus., **12**, pp. 141–168, pls. 34–47, 19 text figures.

Pilgrim, G. E.
1925. The Perissodactyla of the Eocene of Burma. Mem. Geol. Sur. of India. Pal. Indica. N. S., **8**, pp. 1–28, pls. 2.

Schaub, S.
1928. Der Tapirschädel von Haslen. Ein Beitrag zur Revision der Tapiriden Europas. Abhld. der Schw. Palaeont. Ges., **47**, pp. 1–28, pl. 1, 7 text figures.

Schlaikjer, E. M.
1935. New vertebrates and the stratigraphy of the Oligocene and early Miocene. Bull. Mus. Comp. Zoöl., **76**, pp. 95–190, pls. 41, 13 text figures.

Sinclair, W. J.
1901. The discovery of a new fossil tapir in Oregon. Jour. Geol., **9**, pp. 702–707, 1 text figure.

Troxell, E. L.
1922. Helaletes redefined. Amer. Jour. Sci., ser. 5, **3**, pp. 365–370, 3 text figures.

Wortman, J. L., and Earle, C.
1893. Ancestors of the tapir from the lower Miocene of Dakota. Bull. Amer. Mus., **5**, pp. 159–180, 7 text figures.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
Vol. LXXX, No. 5

A STUDY OF PARAHIPPUS WYOMINGENSIS AND A DISCUSSION OF THE PHYLOGENY OF THE GENUS

By Erich Maren Schlaikjer

With One Plate

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
January, 1937

No. 5. — *A Study of Parahippus Wyomingensis and a Discussion of the Phylogeny of the Genus*

By Erich Maren Schlaikjer

INTRODUCTION

In a recent paper (1935 pp. 148–151) the writer gave a brief description of a new species of *Parahippus* to which the name *P. wyomingensis* was applied. The specimen was collected from the lower part of the upper Harrison formation in the Goshen Hole Area, Wyoming. It is the most complete skeleton of *Parahippus* recorded and is the first to be mounted. It affords most of the desired information concerning the osteology of this genus.

Previous osteological considerations of *Parahippus* have been limited to descriptions of scanty skeletal parts belonging to the type specimens, and to generalities about the evolutionary stage represented by certain characters particularly of the skull and feet. It is intended, therefore, in this paper to present a detailed study of this species together with a discussion of the affinities and phylogeny of all the species which can without question be assigned to the genus *Parahippus*.

The specimen was prepared by Mr. F. I. Emery, Jr. and was mounted for exhibition by Mr. George Nelson.

DESCRIPTION

The skeleton is in an unusually fine state of preservation without the slightest bit of distortion evident in any part. Unfortunately some portions were destroyed by erosion. The more important missing parts are the following: the caudal vertebrae; the sternum; some of the ribs; most of the dorsals; and parts of the front feet.

Upper Dentition

The upper dentition is completely and perfectly preserved. The incisors are small and are arranged in semi-circular fashion so that I^3 is situated considerably posterior to I^1. The long axis of the I^3 crown occupies almost an antero-posterior position. I^1 is considerably larger than I^2 or I^3. I^{1-2} are quite worn although the remaining patches of enamel in the centers of the crowns show that they were deeply cupped but without cement. I^3 is deeply cupped. The cup is open postero-

externally, however, since the cingule has united with the external part of the crown only antero-externally. In this character I^3 is primitive. The crowns of the incisors are tall.

The canine is situated a short distance behind I^3. It is diminutive and short-crowned. Its strong posterior basal cusp gives it a decided incisor appearance.

P^1 is large. It consists of a large antero-external cusp and a somewhat smaller postero-internal cusp. They are connected externally by a strong sharply curved ridge and internally by a well developed cingulum. This tooth was functional. P^2 is the longest and narrowest tooth of the P^2–M^3 series. It does not possess a crochet on the metaloph. A fairly strong crochet is present on P^3–M^3. The metaloph and crochet are simple in construction. P^3 and P^4 are longer than any of the molars. P^4 is the largest tooth in the premolar-molar series. P^3 and M^2 are of equal breadth. P^2–M^3 have small hypostyles situated close to the hypocones. The hypostyles are connected with the ectolophs by straight narrow ridges which give straight posterior margins to the teeth. This is particularly true of M^3. The cheek teeth are brachyodont and are devoid of cement. When the skull is viewed from the side, the tooth row exhibits a gently convex profile in antero-posterior dimension.

The Skull

The skull is in a perfect state of preservation. The foramen magnum is nearly circular in outline. The occipital condyles occupy a somewhat oblique position. Above, they are broadly separated and terminate abruptly at fairly deep kidney-shaped depressions. Ventrally, they are separated by a narrow groove and the articular surfaces extend anteriorly as far as they do in *Equus*. The basioccipital and basisphenoid are elongated and at their union, the two basilar tubercles are pronounced. The basisphenoid is strongly arched posteriorly and less so anteriorly as it extends under the thin, narrow and V-notched vomer.

The paroccipital process is expanded antero-posteriorly. It extends below the level of the occipital condyles and curves forward distally. The condyloid fossa is extensive and rounded, and the hypoglossal foramen is large and posteriorly placed in the fossa.

The bulla is small and the muscular process is flattened and large. The hyoid process is large and almost completely enclosed in a bony tube. Posteriorly situated, between the bulla and the mastoid process, is a small stylo-mastoid foramen. The mastoid process is small and concave externally and the external acoustic meatus is circular in out-

line, is projected slightly backwards and its position is quite far behind the postglenoid process of the squamosal.

The supraoccipital when viewed posteriorly is pyramidal in general outline. A fairly strong median ridge is present on the median line of the upper half of the bone, and on either side of this is a well marked depression. Suturial fusion prevents an accurate determination of the interparietal boundaries. The lambdoid crest is strong and rugose.

The squamosal is large and the cranial portion is extended considerably antero-posteriorly. It displays a number of foramina and vascular impressions in the proximity of the lambdoid crest. The zygomatic portion overlaps the malar and extends forward to form a small portion of the inferior border of the orbit, where it is developed into a low process which was incompletely united with the postorbital bar of the frontal. The arch is gently convex dorso-ventrally and antero-posteriorly and it extends a short distance behind the large rugose postglenoid process. The glenoid cavity is narrow and shallow and the condyle is gently convex antero-posteriorly and transversely elongated in which dimension it is slightly concave.

The parietal is long and narrow, somewhat more so behind than in front. Posteriorly, foramina and large vascular impressions are abundant. The sagittal crest is high, and anteriorly it becomes low and separates into the frontal crests.

The frontal extends quite far behind the postorbital bar and is constricted and flattened in that region. Between the orbits the frontals are markedly convex transversely and anteriorly they form a short sharp point at the median line which is wedged between the nasals. The postorbital process is fairly strong and, although, as preserved it does not meet the malar, it probably did have a loose contact with that bone. Coincident with the enlargement of the postorbital process, the supraorbital artery and the frontal nerve became completely surrounded by bone and the supraorbital foramen was formed. In earlier genera this foramen is represented by an open groove.

The lachrymal forms about three-fourths of the anterior border of the orbit. The facial portion is extensive and rounded in marginal outline. It presents a strong lachrymal tubercle and a considerable part of the fairly deep antorbital depression. The lachrymal fossa is large, oval-shaped and is situated a short distance in from the margin of the orbit.

The nasals are elongated. They are wide posteriorly, constricted near the middle, wide again at the contact with the premaxillaries and become pointedly narrow distally. Transversely they are concave ex-

cept near the middle where a prominence is present which gives to the face an undulatory profile. The lateral margin of the nasal projects downward a short distance on the side of the face and on this portion is developed the superior border of the antorbital depression.

The alveolar portion of the premaxillaries is long, narrow and deep. The palatine processes are narrow, elongated and fairly heavy anteriorly. Antero-laterally they are quite separated from the maxillaries and premaxillaries, hence the palatine fissures are large. The foramen incisivum is well developed and is circular in outline. The nasal processes flare slightly outward just above the alveolar portion and then continue upward and backward in parallel fashion and curve slightly inward to meet the nasals. The facial portion of the nasal process is rather expanded antero-posteriorly, especially at the point where it meets the nasal and maxillary. It is of interest to note that there is a proportionate shortening of the nasal process of the premaxillary in this dimension from the earliest horses to *Equus*. This shortening seems coincident with the posterior extension of the naso-premaxillary notch [1] which in *Parahippus* is situated a very short distance in front of P^1.

The upper part of the facial portion of the maxillary is concave with a low ridge separating the "subnasal" fossa from the confluent "lachrimal"-"malar" fossa. The buccinator fossa is deep and is confluent with the "subnasal" fossa. The facial crest is heavy and expanded, and extends forward to the anterior of M^2. The anterior parts of these crests are developed on the maxillaries, across which the skull has its broadest dimension. The infraorbital foramen is situated above the posterior of P^3 approximately two-fifths of the way up on the side of the face. Across the diastema, the maxillaries are constricted and each is developed into a narrow and high ridge. The palatine surface is abruptly convex, thus causing the palate to be very narrow and deep. The alveolar tuberosity is square in outline and protrudes about three-quarters of an inch behind the last molar.

The posterior part of the palate is incompletely preserved. The anterior margin of the internal nares, however, as shown by the preserved parts, probably was opposite the posterior of the first molars. The anterior palatine foramen is of moderate size and is preceded by a short and shallow palatine groove. The perpendicular wall of the palatine is high and postero-inferiorly it presents a blunt and heavy

[1] Sisson and others use the term "naso-maxillary notch". Since the maxillary never enters into the formation of this notch and since it is always formed by the premaxillary and nasal, the term "naso-premaxillary" notch seems more appropriate.

pterygoid process. The pterygoids are thin and small and are compressed against the palatines, thus forming the posterior part of the walls of the internal nares. The basal portion of the alisphenoid is oblique in position, as it extends laterally and dorsally along the base of the brain. The ascending wing bends gently upward and forward and continues about half way up on the side of the brain case. The foramen orbitale and the ethmoidal foramen are subequal in size. Between these is the larger and more round optic foramen. The foramen rotundum is below and posterior to the foramen orbitale, and with it the alar canal opens in common as in the recent horse. Of the three anterior orbital foramina, the maxillary foramen is much the largest and is quite distantly separated from the sphenopalatine foramen. The latter equals in size and is set close to the posterior palatine foramen.

The Skull in General

In general outline the skull is long and narrow. The extended and transversely constricted facial area, the relatively narrow cerebral region, the pronounced postorbital constriction and the short diameter across the frontals designate the skull as one of light construction. In keeping with these features, the palate is long, deep and exceptionally narrow; and the whole basicranial region is elongated and lightly built,—although it possesses a decided similarity to that of *Equus*.

The narrow dimension across the alveolar portion of the premaxillaries, the small incisor three with its incompletely cupped crown, the extraordinarily incisiform canine, the brachyodont cheek teeth which are without cement, and the open faciocranial angle (see Osborn 1929, pp. 256–257) are all characters which exemplify an early stage in *Parahippus* evolution. The proportionately short molar series, the relatively broadened cheek teeth and the advanced development of the crochet, however, together with other progressive characters of the skull indicate an evolutionary stage intermediate, structurally at least, between *P. tyleri* and *P. nebrascensis*.

Lower Dentition

Of the incisor teeth, only the right I_2 is preserved. It is tall-crowned, triangular in outline and although the crown is somewhat worn, the posterior surface presents the remnant of a complete but shallow cup. As is indicated from the preserved roots of the other incisors, I_1 was the largest and I_3 the smallest of the series.

A striking condition of the lower dentition is the absence of canines. To be sure, loss or reduction of the canines is not unusual among the Equidae. It is unusual, however, for the canines to be lost in such an early stage in the evolution of the horse. In addition, it is equally as extraordinary for the lower canines to be lost when the upper canines are present and especially when the latter are so primitive in form. In *Equus*, if canines are present, the lower ones are almost always the larger pair, and for that pair to persist after the uppers have been lost is frequently the case.

The first premolar is not preserved. The alveolus shows that it was much reduced in size. Probably it was non-functional. P_2 is elongated and is laterally compressed anteriorly. P_{3-4} are completely molariform and are proportionately very broad, P_4 more so than P_3. M_1 and M_2 are smaller than either P_3 or P_4. The hypoconulid of M_3 is large, pillar-like and centrally placed. There is a diminutive external cingulum on each of the cheek teeth.

The Mandible

The horizontal ramus is long and slender and tapers gradually toward the front. In vertical section it is biconvex, especially in the central area. The alveolar portion is very narrow which causes an oblique alignment of the incisor teeth. The symphysial region is long, very narrow and is directed only slightly upward from the remaining portion of the horizontal ramus. The diastema is long and the symphysis is transversely constricted very abruptly, immediately behind incisor three. Its dorso-lateral margins are developed into high thin edges. The mental foramen is small and is situated about midway between incisor three and premolar one. The ventral portion of the ramus is wavy in profile and the vascular impression is only faintly marked. The angle is gently rounded. Dorso-ventrally it is straight and of uniform thickness. The fovea pterygoidea is extensive and is especially deep anteriorly. The foramen mandibulare is large and is situated on a level slightly above the base of the tooth row. The condyle is transversely elongated, club-shaped in outline when viewed from above and is convex transversly as well as antero-posteriorly. It occupies a position far above the tooth row. The coronoid process is long and slender. It is curved considerably backward and slightly inward.

Measurements of Skull

	mm.
Basal length	295.0
Condylo-basal length	312.7
Zygomatic breadth (just posterior to M^1)	114.7
Greatest breadth across squamosals on malar arches	111.1
Greatest breadth across squamosals on cranium	54.5
Breadth on upper rim of postglenoid notch	59.4
Interorbital breadth across frontals	72.3
Distance from anterior rim of orbit to pmx.	171.2
Distance from anterior rim of orbit to supraoccipital crest	173.1
Distance from posterior of mandibular condyle to pmx.	267.7
Breadth of muzzle at anterior root of M^1	87.2
Distance from anterior end of internal nares to pmx. (I alveoli)	156.7
Distance from anterior end of internal nares to condyles	156.0
Greatest width of condyles	51.5
Distance from ventral portion of exocc. to top of supraocc.	82.2
Width of premaxillaries at posterior of I^3 alveoli	35.7
Breadth across P^2 to P^2 at center of crown	57.5
Breadth across P^4 to P^4 at center of crown	73.2
Breadth across M^1 to M^1 at center of crown	77.5
Breadth across M^3 to M^3 at center of crown	78.4
Length of diastema (I^3 to P^1) external	52.0
Length of diastema (I^3 to C) external	8.9
Cheek teeth on alveoli (P^1 to M^3) external	116.8
Distance from P^2 to P^4 on alveoli (external)	59.0
Distance from M^1 to M^3 on alveoli (external)	52.0
Lateral distance across I^1	11.1
Fore and aft distance at center of I^1	8.0
Lateral distance across I^2	9.7
Fore and aft distance at center of I^2	7.0
Lateral distance across I^3	9.6
Fore and aft distance at center of I^3	6.5
Breadth of P^2 at center of crown	20.0
Length of P^2 at center of crown	18.6
Breadth of P^4 at center of crown	23.7
Length of P^4 at center of crown	18.5
Breadth of M^1 at center of crown	23.4
Length of M^1 at center of crown	17.3
Breadth of M^3 at center of crown	21.7

Length of M^3 at center of crown	16.6
Greatest breadth of M^3	24.7
Greatest length of M^3	18.6

Measurements of the Jaw

Posterior of I_1 (on alveolus) to condyle	255.1
Posterior of I_1 to M_3 on alveoli	178.4
Depth of jaw under anterior of M_1	37.8
Width of condyle	34.0
Distance from P_1 to P_4	55.7
Distance from M_1 to M_3	58.1
Length of P_2 internal	20.0
Greatest width of P_2	14.7
Length of P_3 at center of crown	17.5
Greatest width of P_3	16.5
Length of P_4 at center of crown	17.9
Greatest width of P_4	17.7
Length of M_1 at center of crown	16.4
Greatest width of M_1	14.9
Greatest length of M_2	23.0
Greatest width of M_3	12.8

The Vertebral Column

Atlas. The atlas is deep and is broad across the wings. The anterior articular cavities are deep, widely separated dorsally and are separated ventrally only by a narrow groove. The dorsal arch presents a median low tubercle. It is deeply notched anteriorly. The intervertebral foramen is large, round and outwardly directed. There is a slight ridge extending posteriorly from its dorsal margin. The posterior articular faces are saddle-shaped. They are constricted and confluent below, erect and widely separated above. The hypapophysial tubercle is prominent, rugose and is posterior in position. The wing is wide and rather short. The notch for the spinal nerve is large, deep and semicircular in outline. The fossa atlantis is deep and oval. A short distance in front of the posterior base of the wing is the foramen transversarium which is large and which faces backward and upward.

Axis. This vertebra is exceptionally long. The odontoid process is large, flattened and blunt. Its latero-ventral surfaces are continuous with the anterior articular surfaces which are very extensive. Dorsally they extend onto the latero-anterior portions of the neural arch.

Below they are closely approximated. The intervertebral foramen is quite posteriorly placed. The ventral spine and the transverse process are very well developed. The neural spine is high and crest-like and the postzygapophyses are wide and posteriorly extended.

Cervicals. All of the cervicals are preserved. In general they are rather large and elongated. The first is the longest,—being nearly as long as the axis; and the fifth is the smallest. There is a low neural ridge on the first and second cervicals. The third presents a low neural spine. This spine is more prominent on the fourth and is fairly long on the fifth. On the first cervical the transverse process is narrow and antero-posteriorly extended. From the first to the last it becomes shorter, wider and heavier. The zygapophyses are large and heavy. There is a very pronounced ventral keel on the first. This keel becomes more diminished on the succeeding vertebrae. In most respects the cervicals are essentially like those of *Equus*, except that the last two are proportionately longer.

Dorsals. All of the dorsal vertebrae, except the eighth and the neural arches of the first and second have been destroyed by erosion. Since there are six lumbar vertebrae, I have assumed that the number of dorsals is eighteen (see plate).

Lumbars. In so far as is known, the complement of lumbars is six. All are present, although the entire neural spines of the first and second and the ends of the last three are gone. The transverse processes are missing on the first three and are partially broken away on the fourth. On the fifth and sixth these processes are much expanded and are extensively articulated. The posterior face on the process of the sixth presents a large articular surface for contact with the lateral wing of the first sacral. There is a fairly pronounced ventral keel on the first four.

Sacrum. Only the first sacral vertebra is preserved. The lateral wing is heavy and has a large, rugose articular surface for articulation with the ilium. This surface faces obliquely upward and backward.

Ribs. Two complete ribs and parts of twelve others were collected. The characters which they display would seem to indicate that the thorax was of moderate dimensions as restored in the mounted skeleton (see plate).

Bones of the Fore Limb

Most of the right limb and a considerable portion of the left are preserved.

Scapula. The scapula is exceptionally long and slender. The glenoid cavity is almost circular in outline. The glenoid notch is shallow. The coracoid process is large, heavy and rugose. It is situated directly lateral from the glenoid cavity and its inferior border is slightly oblique, as in the modern horse. Distally it curves slightly inward. The neck is moderately long. The spine is fairly high and is strongly built. Slightly above its central portion it is rugose and is bent sharply backward. Ventrally it is developed into a long, thin, flattened process. The superior half of the scapula is medially curved, —the anterior margin more so than the posterior. Ventrally it is straight. The fossa subscapularis is large, and the vascular groove is well marked.

Humerus. In keeping with the size and build of the other bones of the limb, the humerus is long and heavy. The head is almost circular in outline and is strongly convex. Its area is about one third larger than that of the glenoid cavity. The postero-external margin is curved downward and is much lower than the internal which, of course, permitted considerable lateral swing of the limb in locomotion. The medial and lateral tuberosities are not preserved. The parts remaining, however, show that the antero-proximal portion of the humerus was broad. The deltoid process is heavy and rugose and the teres tuberosity is low. The shaft is sigmoid in form and is twisted. Centrally it is oval in outline. The distal end is transversely expanded. Medially it is much more antero-posteriorly extended than laterally. The lateral condyloid crest is prominent. The condyles are oblique to the shaft and the epicondyles are well developed. The olecranon fossa is deep and elongated.

Radius. The radius is long and somewhat slender. The proximal end is laterally expanded because of the development of the lateral ligament tuberosity. The shaft is bowed gently forward and is semi-elliptical in cross section. The distal extremity is large. Anteromedially there is a large, open, somewhat oblique groove for the tendon of the extensor carpi obliquus. The antero-lateral groove for the common extensor tendon is rather smaller.

Ulna. The ulna is much reduced although the shaft is complete. The distal end is partially fused with the radius. The olecranon is high, greatly transversely compressed and antero-posteriorly expanded. The semilunar notch is large and deep, and the processus anconaeus is large and pointed.

Carpus. The scaphoid is fairly deep, very irregularly rugose postero-externally, and has a clearly marked anterior surface. The magnum

facet is large and still quite oblique. The lunar is keystone-shaped in general outline. It is much wider in front than behind and the ventro-posterior surface bears a large rounded tuberosity. Laterally it is in contact with the cuneiform only above and below. The unciform facet is about one-third the width of the magnum facet. The dorsal surface is strongly transversely concave posteriorly and convex anteriorly. The cuneiform is not preserved. The pisiform is large, strongly convex and rugose externally, and sharply concave internally. The groove for the long tendon of the ulnaris lateralis is shallow and slightly oblique.

The trapezium is minute. Posteriorly it is developed into an inwardly deflected process. The facet for metacarpal II is greatly reduced and is confluent with the large trapezoid facet. The scaphoid facet is concave and is approximately one-half the size of the trapezoid facet. The trapezoid and magnum are not preserved. The unciform is fairly deep and narrow and is quite lateral in position. The lunar facet is oblique and small. Ventro-posteriorly there is a small, concave semi-circular facet for metacarpal V.

Metacarpus. No one of the metacarpal bones is complete. They are sufficiently preserved, however, to show that each is approximately one-sixth shorter than the corresponding metatarsal and is of somewhat lighter construction. Metacarpal V is not preserved but a small, rounded unciform-metacarpal IV facet indicates that it was small and simple in form.

Phalanges. The phalanges are about the same as those of the hind foot (see description in succeeding pages) except that they are rather less massive and the lateral digits are proportionately slightly longer.

The Fore Limb in General

The fore limb of *P. wyomingensis*, as well as that of the other species of which the limb is known, displays an advancement over *Mesohippus* in all of those characters which are progressively developed throughout the evolution of the horse. The more salient of those characters are as follows:

1. Glenoid notch deepened.
2. Increase of surface of the head of the humerus.
3. Greater reduction of the ulna and partial fusion with the radius distally.
4. Scaphoid occupies a more anterior position in the carpus.
5. Lunar in less continuous contact with the cuneiform.

6. Pisiform in firmer and more extensive contact with the cuneiform.
7. Trapezium with more reduced metacarpal II facet.
8. Metacarpals II and IV and the lateral digits more reduced, which changes are coincident with an increased development of metacarpal III and the third digit.

The Pelvis

The pelvis is almost completely preserved and is without distortion. It is large, elongated, deep, wide in front and narrow behind. The considerable separation of the dorso-distal wings of the ilia, together with the fact that the conjugate and transverse dimensions of the pelvic opening are the same, show that the pelvis is unquestionably that of a female.

The ilium is broad in front. Externally it is slightly concave anteriorly across which area there is a faint gluteal line. Posterior to the gluteal surface there is an abrupt constriction, behind which the ilium becomes semi-elliptical in cross-section,—being convex externally. Antero-dorsally to the acetabulum is a pronounced crest for the attachment of the lateral tendon of the rectus femoris and capsularis. The depression for the medial tendon of the rectus femoris is large and oval-shaped. The acetabular fossa is large, open and leads out into a prominent pubic groove. The ilio-pectineal eminence and the pubic tubercle are not separated.

The obdurator foramen is large and oval in outline. The acetabular branch of the pubis is narrow and is situated at right angles to the acetabulum. The ischium is long, broad and heavy. The symphysial portion is thick and rugose. The ischiatic spine is low and the dorsal surface of the acetabular branch is concave in profile.

As a whole the pelvis of *Parahippus* is remarkably *Equus*-like. Although somewhat more primitive, it is markedly in advance over *Mesohippus,* especially in the proportionately short and broad ischium, the less obliquity of the acetabular branch of the pubis, and in the massiveness of the entire pelvis.

Bones of the Hind Limb

Both of the hind limbs are excellently preserved.

Femur. In keeping with the other limb bones, the femur is long and massive. It is particularly large at the proximal end. The great trochanter is massive, rugose, erect and extends a moderate distance

above the head. The trochanteric fossa is elongated, narrow and deep. The head is almost hemispherical in general form and it faces upward, forward and inward. Its rounded smooth surface is interrupted medially by a very deep, open V-shaped notch for the accessory and round ligaments. Medially and anteriorly the neck is well defined and postero-externally it merges into the great trochanter, although the articular surface of the head is clearly marked. The second trochanter is low, rugose, narrow and elongated,—assuming approximately the same proportions as in the recent horse. The third trochanter is large, projects quite far out from the shaft and is curved forward.

The shaft is curved slightly forward. It is long and heavy, oval in cross section and is prominently constricted just below the third trochanter. The supracondyloid fossa is elongated, deep and narrow.

Distally the femur is expanded antero-posteriorly and transversely. The trochlea is narrow and deep, and the lateral and medial ridges are subequal in size and extent. The condyles are large, are considerably posteriorly placed and are about equal in size. They are placed slightly oblique to the long axis of the shaft. The lateral and medial epicondyles are faintly developed.

Patella. The patella is proportionately more narrow and the apex more developed than that of *Equus.* In these characters it is primitive but much less so than in *Mesohippus.* The attachment for the accessory cartilage is broad, elongated and pitted. The medial articular surface is more extensive than the lateral.

Tibia. The tibia is extremely long and slender and is gently curved posteriorly at the middle of the shaft. The proximal end, when viewed from above, shows a remarkable similarity to *Equus,* though somewhat more primitive. The medial and lateral condyles are saddle-shaped and the intercondyloid eminence is high, the medial portion of which is smaller and more erect than the lateral. The lateral condyle has not yet assumed as transverse a position as in *Equus* and there is no marked groove on it for the popliteus tendon. Nevertheless, it is less oblique than the medial condyle. The popliteal notch is large, open and deep. The soleus muscularis is shallow and open. The tuberosity is moderately pronounced and on its medial side there is a well defined groove for the middle patellar ligament. The crest is very massive and prominent proximally. It is situated centrally for about a fifth of the tibia's length and then curves medially and merges into the shaft which then becomes circular in cross section. The distal end of the tibia is flattened antero-posteriorly and presents fairly strong medial and lateral malleoli. The groove for the flexor digitalis longus tendon

is large and trough-like. The groove for the lateral extensor tendon is incipient. The articular grooves are oblique in position and are deep and narrow, the medial more so than the lateral.

Fibula. The proximal end of the fibula is transversely compressed and is rounded posteriorly, dorsally and anteriorly. The shaft amounts to nothing more than a splinter of bone which extends downward two-thirds the length of the tibia. The distal end is completely fused to the tibia. The astragular facet is extensive and the calcanear facet small and flattened.

Tarsus. The calcaneum is transversely compressed and elongated. The proximal end is oval in outline, large and rugose. The tarsal groove is in the form of a deep notch. The processus cochlearis is pronounced and superiorly it possesses a small rounded fibular facet. On the distal extremity is an elongated, concave and oblique facet with which about three-fourths of the proximal surface of the cuboid articulates.

The astragalus is almost as progressive in its characters as is that of *Equus.* The trochlear ridges are oblique in position and the medial one is confluent with the navicular facet. The trochlear groove is deep and posteriorly it grades into the tarsal groove of the calcaneum. The navicular facet is convex transversely and antero-posteriorly. The main part of this facet is separated by a sharp ridge from the postero-median rounded navicular facet. Between this and the triangular oblique cuboid facet is a curved non-articular depression. This depression does not occur in the astragalus of any of the earlier genera of horses,—and its presence, together with the development and arrangement of the posterior navicular and the cuboid facets, is an advancement in equine limb evolution which probably resulted in greater assurance against lateral disjointing of the tarsus.

The cuboid is large and massive. Its depth is not as great as its antero-posterior dimension. The proximal surface is transversely convex and is antero-posteriorly concave on the anterior portion. The plantar ligament tuberosity is large, rounded and rugose. On the distal surface is a large triangular facet for metatarsal four and a smaller quadrangular oblique facet for metatarsal three. The ecto-cuneiform is broad and low and its anterior surface is very rugose for the attachment of the main body of the dorsal ligament. The meso- and ento-cuneiforms are completely coalesced. The ento-cuneiform is deep, transversely expanded and is in strong contact with the cuboid. The meso-cuneiform does not come in contact with metatarsal three. This is a generic character of *Parahippus* as is shown in the known material.

Metatarsus. Metatarsal III is extremely elongated for *Parahippus.* Proximally it possesses a small quadrangular cuboid facet, but no meso-cuneiform facet. There is only a slight beginning of a non-articular depression. The distal end is expanded and massive. The lateral tubercles are prominent and between them on the dorsal side just above the articular surface is an elongated shallow pit. The whole distal articular surface is bent slightly backward. Metatarsals II and IV are considerably shorter than metatarsal III,—metatarsal II more so than metatarsal IV. Their proximal ends are heavy and transversely compressed. The shafts become lighter distally and are most slender at about three-fourths of their lengths.

Phalanges. The lateral digits are much reduced and were nonfunctional, at least in standing position. The first phalanx is long and slender; the second is short and stubby with an elongated postero-ventral prominence; and the ungual is compressed, pointed and the ventral posterior angle is much elongated. The phalanges of the middle digit are very much larger. The first is elongated and flattened dorso-ventrally. The proximal end is broad and presents large tuberosities. The distal end is not only more flattened but is narrower transversely. The second phalanx is short and stubby and its transverse dimension equals that of its length. The ungual phalanx is slightly longer than it is wide. In general structure it is like that of the more advanced Equidae although more primitive in the following characters: more pointed; slope of its dorsal surface less steep; angles more anterior; postero-ventral margin does not extend as far posteriorly; and, distal border notched. The spongy character of the dorso-lateral surface, the presence of the dorsal groove and of a great number of foramina indicate, however, that the phalanx was probably entirely covered by a hoof. In all of the above mentioned characters, the ungual phalanx shows a decided advancement over that of *Mesohippus.*

The Hind Limb in General

There is hardly a single element of the hind limb of *Parahippus* which does not display characters that are advanced, in the direction of *Equus,* over those of *Mesohippus.* The most outstanding feature of the hind limb of *P. wyomingensis* is its extraordinary length. The skull of this species is approximately the same size as that of *P. tyleri,* yet the limbs are longer than in any other species. This elongation was brought about mainly by a lengthening of the proximal limb elements, particu-

larly the tibia, for as is shown in Table 1, metatarsal III is proportionately shorter in this species than in such species as *P. tyleri* or *P. nebrascensis.*

Species	Femur max. length	Tibia max. length	Met. III max. length	Femur-Met. III ratio	Tibia-Met. III ratio
P. tyleri Amer. Mus. 13,769	276.0	286.0	198.0	.713	.692
P. nebrascensis Carn. Mus. 1,440	325.0	325.0	?	?	?
P. nebrascensis Amer. Mus. 13,807	285.0	303.0	203.5	.714	.672
P. wyomingensis M. C. Z. 6,390	320.0	344.5	223.4	.698	.663

TABLE 1. Femur-metatarsal III and tibia-metatarsal III ratios of three *Parahippus* species.

Measurements of the Limbs

	mm.
Length of scapula (estimated)	230.0
Fore and aft diameter of glenoid cavity	39.4
Transverse diameter of glenoid cavity	35.6
Distance from coracoid process to posterior rim of glenoid cavity	58.6
Narrowest fore and aft distance of neck of scapula	30.4
Length of humerus, head to posterior trochlea	198.8
Shortest width of shaft	21.7
Shortest fore and aft distance of shaft	28.9
Width of distal end of humerus on lateral ligament depressions	46.5
Greatest width of proximal end of radius	47.3
Greatest width of distal end of radius	45.6
Width at center of radius shaft	25.2
Greatest height of scaphoid	23.2
Greatest height of lunar	23.2
Greatest height of cuneiform	20.6
Greatest width at proximal end of metacarpal III	27.2

Greatest width at distal end of metacarpal III	30.4
Lateral median length of first phalanx, third digit	37.7
Greatest length of second phalanx, third digit	28.1
Median dorsal length of ungual phalanx, third digit	34.8
Greatest length of femur	320.0
Length of femur from head to internal trochlear ridge	291.6
Length of femur, center of 3d trochanter, to external trochlear ridge	212.0
Shortest transverse measurement of femur shaft	25.4
Distance across condyles of femur	56.4
Length of tibia from medial condyle to internal malleolus	344.5
Length of fibula	312.0
Greatest length of calcaneum	91.7
Maximum length of metatarsal III	223.4
Maximum width, proximally, of metatarsal III	30.2
Maximum width, distally, of metatarsal III	30.0
Maximum length of metatarsal IV	209.0
Greatest length of first phalanx, 3d digit	42.8
Greatest length of second phalanx, 3d digit	29.7
Length of ungual phalanx, 3d digit, dorsal	40.7
Width of ungual phalanx, 3d digit, across angles	35.5

AFFINITIES

Sixteen species and three subspecies can unquestionably be referred to the genus *Parahippus*. These, together with the geologic formation and locality of each type, are as follows:

Parahippus pristinus Osborn	Lower Harrison	So. Dakota
Parahippus tyleri Loomis	Upper part of L. Harrison	Nebraska
Parahippus wyomingensis Schlaikjer	Lower part of U. Harrison	Wyoming
Parahippus agrestis (Leidy)	Probably Fort Logan	Montana
P. pawniensis atavus Osborn	Upper Harrison	Nebraska
Parahippus nebrascensis Peterson	Upper Harrison	Nebraska
P. nebrascensis primus Osborn	Upper Harrison	Nebraska
Parahippus australis (Leidy)	Middle or lower Miocene	Texas
Parahippus texanus (Leidy)	Middle or lower Miocene	Texas
P. coloradensis praecurrens Osborn	Upper Harrison	So. Dakota
Parahippus cognatus Leidy	Sheep Creek	Nebraska
Parahippus leonensis Sellards	Hawthorn	Florida
Parahippus minutalis Hay	Upper Miocene?	Texas

Parahippus avus (Marsh)	Mascall	Oregon
Parahippus crenidens (Scott)	Deep River	Montana
Parahippus pawniensis Gidley	Pawnee Creek	Colorado
Parahippus intiger Matthew	Lower Snake Creek	Nebraska
Parahippus brevidens (Marsh)	Mascall?	Oregon
Parahippus coloradensis Gidley	Pawnee Creek	Colorado

In 1900 Douglass described *Anchitherium minimus* from the Madison Valley. Professor Osborn (1918, pp. 96–97) has referred this species to *Parahippus*. The several superior teeth show, however, that the metaloph on P^3 and P^4 is only slightly crenulated and there is no crochet on these teeth or on M^1 (the only upper molar known). It would seem more logical, therefore, on the strength of this, and since the species is small, to refer it to *Archaeohippus*.

Another species described by Mr. Douglass (1908, pp. 271–273) as *Altippus taxus* was referred to *Parahippus* by Professor Osborn in 1918. The type is that of a young individual of which only the upper cheek teeth and part of a hind limb are known. Mr. Douglass stressed the importance of the elongated limb bones. In dental characters this species is, without question, referable to *Miohippus*. This is especially shown in the absence of a crochet on the metaloph and the lack of union of the metaloph and ectoloph. The hind limb is not of undue length for this genus. In the collection of fossil horses in the American Museum there is a specimen (No. 7271) of a juvenile individual from the John Day beds which Professor Osborn regarded as the paratype of his species *Miohippus primus* (1918, p. 61). Additional preparation of this specimen reveals that it is quite different from the type, particularly in the following characters: (1) the teeth are more hypsodont and less quadrangular in form; and, (2) the protoconule is not nearly as confluent with the protocone. With negligible exceptions the specimen seems identical, even in the length of the limb bones, with *M. taxus*.

Professor J. C. Merriam described *Parahippus* (?) *mourningi* (1913, p. 427) from the Barstow beds of the upper Miocene. This species was rightfully considered by Professor Osborn (1918, p. 213) as belonging to *Archaeohippus* since it is a small form without a definite crochet on the metaloph.[1] (Recently,—1935, pp. 142–146, I have stressed the im-

[1] In his recent paper on "Anchiteriine horses from the *Merychippus* zone of the North Coalinga District, California", Mr. Francis D. Bode also places this species in *Archaeihippus*. I also fully agree with Mr. Bode in his conclusion that *Archaeohippus* is a distinct genus, as maintained by Mr. Gidley, and not a subgenus of *Parahippus* as suggested by Dr. Matthew in 1932.

portance of the development of the crochet in *Pediohippus* and *Parahippus*).

The following is a brief discussion of the relationships of each of the *Parahippus* species and their phylogenetic arrangement is tentatively shown in Figure 1.

Parahippus pristinus Osborn is a primitive, generalized form and holds a correct morphologic as well as a correct stratigraphic position to be the progenitor of all of the known species of *Parahippus*, and it is the direct descendant of *Pediohippus*.

P. tyleri Loomis and *P. wyomingensis* Schlaikjer represent admirable intermediate stages, in the large, wide and brachyodont teeth as well as in other skull and skeletal characters, between *P. pristinus* and *P. nebrascensis* Peterson and *P. n. primus* Osborn, the largest (in skull size at least) of all the known species. *P. australis* (Leidy) is known only from the second right upper premolar. The position and isolation of the internal cusps (protocone and hypocone) indicate an evolutionary stage about the same as that of *P. nebrascensis*, although it is a smaller form. With the evidence at hand, there is nothing to rule *P. wyomingensis* out of its direct ancestry. The exact geologic level from which it comes is uncertain. It probably came from the uppermost part of the lower Miocene. *P. agrestis* (Leidy) comes from approximately the same level. The type consists of three left lower teeth, P_4-M_1 and M_2. It is somewhat smaller than *P. avus* (Marsh) and is without enamel. Nevertheless, of the known forms, it resembles this species most closely in tooth form and proportions and may be its direct lower Miocene ancestor. *P. avus* is a brachyodont form from the middle or upper Miocene. It represents a primitive line persisting late in the Miocene. Specialized in dentition by the presence of cement but primitive in the simple crests and low crowns of the teeth. It is persistently primitive especially in the weak development of the crochet.

P. minutalis Hay is the smallest of all the known species of *Parahippus*. It is represented by isolated upper teeth which were found, according to Hay, in the upper Miocene of Texas. The teeth are brachyodont, possess no cement and are simple in construction. The crochet is well developed but is not confluent with the protoloph. The metaloph and protoloph are simple. In size it is about three-fourths that of *P. pristinus* and it is almost equally as primitive. It seems almost incredible for a form as primitive as this to occur as late as the

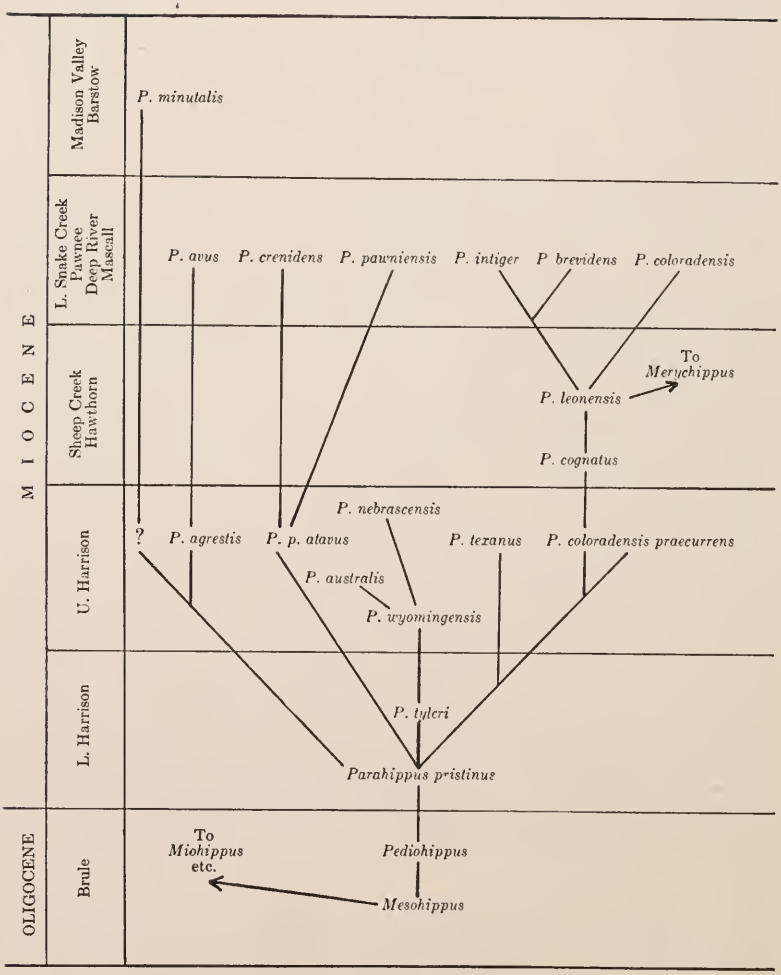


FIGURE 1. The phylogeny of *Parahippus*. Schlaikjer 1934.

upper Miocene. It is possible that the specimens were derived from earlier strata or that the beds in which they were found are earlier in age. Nevertheless, *P. minutalis* represents a dwarf *Parahippus*, and because of its primitiveness it is tentatively derived from an early line closely allied to that of *P. avus* and coming directly from *P. pristinus*.

P. crenidens (Scott) and *P. pawniensis* Gidley are two closely related brachyodont forms, although the former is somewhat the more advanced. It is rather larger, possesses cement and has a crenulate metaloph. *P. pawniensis* presents only a slight amount of cement and the metaloph is incipiently crenulate. The latter is especially true of P^4 and M^1. The metacarpals of both are slender and elongated (none of the other skeletal parts are adequately known). In addition to the dental features, this character also substantiates the close affinity of the two species.

The dentition of *P. pawniensis atavus* Osborn is not known. The occiput as well as the skeletal remains indicate a small form, somewhat larger than *P. pristinus*; and, the construction and proportions of the metacarpals indicate that it is close to *P. crenidens* and *P. pawniensis*. When better known, it may prove to be ancestral to these species. It is provisionally assigned to such a phylongenetic position.

P. texanus (Leidy) consists of a single left upper molar and its geologic level is uncertain. It represents an evolutionary stage, however, of about lower middle or uppermost lower Miocene. It is a relatively small, progressive, brachyodont form and is closely related to an advanced line which was derived from the pre-*P. tyleri Parahippus* stock, and which line probably gave rise to the *P. cognatus-leonensis* group. A fine palate, No. 12924, in the American Museum collection from the upper Harrison (Rosebud) has been referred by Professor Osborn (1918, p. 89) to this species. This specimen is, however, much larger and is more primitive especially in the weaker development of the crochet and in having the protoconule less restricted from the protocone. In size and stage of development, it is much closer to *P. nebrascensis* Peterson (see Osborn 1918, pl. 9 and Peterson 1908, pl. 19), although P^2 is more quadrangular, a character which is probably variable in this genus as in *Mesohippus* and *Pediohippus*.

P. cognatus Leidy, until recently, was known only by the left upper deciduous premolars two to four. In 1924 Matthew (pp. 155–157) described a young skull and jaws, Amer. Mus. 14305, from the middle Miocene beds near Marsland, Nebraska. In this specimen the de-

ciduous dentition and the right upper first molar are splendidly preserved. As shown by Dr. Matthew, the milk dentition is almost identical with *P. cognatus*. M^1 is hypsodont, the crochet is well developed and the constriction between the protocone and the protoconule is very pronounced. The first upper molar of *P. coloradensis praecurrens* Osborn (1918, p. 83) from the upper Rosebud, is not known. All of the characters preserved in M^2, however, are almost identical with the first molar of the Marsland specimen. It is probable that when the permanent dentition of *P. cognatus* is completely known, *P. coloradensis praecurrens* can be definitely referred to that species.

The type *P. leonensis* Sellards is based on isolated teeth. Recently, however, additional and more complete material from the same locality has been described and figured by Dr. Simpson (1932, pp. 22–27). *P. leonensis*, in every important character such as size, complication of the crochet, protocone-protoconule constriction, presence of cement and hypsodonty, forms an admirable morphologic as well as stratigraphic stage ancestral to *Merychippus* and to *P. intiger*, *P. brevidens* and *P. coloradensis*. In all of these characters, *P. cognatus* is equally as ideal a progenitor of *P. leonensis*.

P. intiger Matthew, *P. brevidens* (Marsh) and *P. coloradensis* Gidley are all closely related and specialized species which occur at approximately the same geologic level. As pointed out by Dr. Matthew (1924, p. 157) *P. intiger* and *P. brevidens* are closely related. *P. coloradensis* is somewhat more primitive, especially in possessing a lesser amount of cement, and for this reason it is placed in Figure 1 as coming directly from *P. leonensis*, rather than from the *P. intiger-brevidens* line.

According to Professor Osborn (1918, p. 74), Dr. Matthew, in unpublished notes on the Equidae, arranged the species of *Parahippus* into three groups "distinguished by the characters of the grinding teeth and of the preorbital fossae, and by the stout or relatively slender limbs." In addition, Dr. Matthew stressed the importance of the ungual phalanges. Dr. Matthew's grouping of the species does not seem altogether justifiable. For example, *P. coloradensis praecurrens* is listed as having ungual phalanges of moderate length, when, as is shown in Table 2, it has proportionately shorter unguals than in any other species, in so far as is known. Also, the ungual phalanges of *P. nebrascensis* are considered as small. In reality, the ungual phalanx of the third digit is larger than in any other species,—being somewhat larger than that of *P. wyomingensis*. There seems to be, however, a general tendency for the proportionate widening of the ungual in

each phylum. Although it must be kept in mind that adequate material is still insufficient.

Species	Length	Width	Index
Parahippus pristinus	26.0	19.0	.730
P. pawniensis atavus	33.0	26.0	.790
Parahippus avus	35.5	30.0	.845
Parahippus leonensis	28.0	24.0	.856
Parahippus tyleri	39.0	33.5	.859
Parahippus wyomingensis	40.7	35.5	.872
P. coloradensis praecurrens	35.0	31.0	.886

TABLE 2. Measurements and indices of the ungual phalanx, digit III, of the pes of seven *Parahippus* species. Schlaikjer, 1934.

Parahippus cognatus is included in Dr. Matthew's group I, having "relatively short-crowned teeth." The cheek teeth of this species certainly are as hypsodont as those of *P. coloradensis* or *P. c. praecurrens* which are unquestionably typical hypsodont species.

On the basis of the available material the following conclusions, concerning the phylogeny of *Parahippus*, seem most logical.

1. All of the species can be included in two groups,—those with brachyodont and those with hypsodont teeth.

2. *Parahippus pristinus* from the lower Miocene (lower Harrison formation) is a member of the brachyodont group, and in nearly every known character is an ideal ancestral stage not far removed from *Pediohippus* of the Oligocene.

3. In the *P. tyleri-wyomingensis-nebrascensis* line of brachyodont forms, there is a tendency toward gigantism with the development of large teeth and excessively long limbs. These specializations seem to indicate, especially in *P. wyomingensis*, a forest-living habit.

4. *Parahippus avus, P. crenidens* and *P. pawniensis* are the most advanced of the brachyodont species. They are progressive in such characters as the development of cement on the teeth, the tendency toward a proportionate elongation of the distal limb elements and a widening of the ungual phalanges. They exist late in the Miocene.

5. A line of dwarf forms in the brachyodont group is represented by *Parahippus minutalis.*

6. Among the hyposodont species a form such as *Parahippus leonensis* gave rise to *Merychippus* early in the middle Miocene. *P. intiger, P. brevidens* and *P. coloradensis* are hypsodont species that exist in late Miocene times along with various species of *Merychippus.*

BIBLIOGRAPHY

Bode, F. D.

1934. Anchitherine horses from the *Merychippus* zone of the North Coalinga District, California. Publ. Carn. Inst. Wash., No. 440, pp. 43–58, pls. 1–5.

Douglass, E.

1900. The Neocene lake beds of western Montana and descriptions of some new vertebrates from the Loup Fork. A thesis for the degree of M. S. in the University of Montana, June 1899. Published by the University, pp. 3–27, pls. 1–4.

1908. Fossil horses from North Dakota and Montana. Ann. Carn. Mus., **4**, pp. 267–277, pls. 65–68.

Hay, O. P.

1924. Description of some fossil vertebrates from the Upper Miocene of Texas. Proc. Biol. Soc. Wash., **37**, pp. 1–20, pls. 1–6, 1 text figure.

Matthew, W. D.

1924. Third Contribution to the Snake Creek Fauna. Bull. Amer. Mus. Nat. Hist., **50**, pp. 59–210, 63 text figures.

Merriam, J. C.

1913. New anchitherine horses from the Tertiary of the Great Basin area. Bull. Dept. Geol. Univ. Calif., **7**, pp. 419–434, 5 text figures.

1919. Tertiary mammalian faunas of the Mohave Desert. Bull. Dept. Geol. Univ. Calif., **11**, No. 5, pp. 437a–437e, 438–585, 253 text figures.

Osborn, H. F.

1918. Equidae of the Oligocene, Miocene and Pliocene of North America. Iconographic type revision. Mem. Amer. Mus. Nat. Hist., n.s., **2**, pp. 1–217, pl. 1–54, 173 text figures.

1929. The titanotheres of ancient Wyoming, Dakota and Nebraska. U. S. Geol. Surv. monograph 55, pts. 1 and 2, pp. 1–953, pls. 1–236, 797 text figures.

Osborn, H. F. and Wortman, J. L.

1895. Perissodactyls of the Lower Miocene White River beds. Bull. Amer. Mus. Nat. Hist., **7**, pp. 343–375, pls. 8–11, 12 text figures.

Peterson, O. A.

1908. The Miocene Beds of western Nebraska and eastern Wyoming and their vertebrate faunae. Ann. Carn. Mus., **4**, pp. 21–72, pls. 9–19, 20 text figures.

Romer, A. S.

1926. A lower Miocene horse, *Anchitherium agatense* (Osborn). Amer. Jour. Sci., fifth series, **12**, No. 70, pp. 325–335, 4 text figures.

Schlaikjer, E. M.

1935. Contributions to the stratigraphy and palaeontology of the Goshen Hole Area, Wyoming. Part IV. New vertebrates and the stratigraphy of the Oligocene and early Miocene. Bull. Mus. Comp. Zoöl., **76**, No. 4, pp. 95–189, 41 plates, 13 text figures.

Scott, W. B.

1893. The Mammalia of the Deep River Beds. Trans. Amer. Phil. Soc., n.s., **18**, pp. 55–185, pls. 1–6.

Simpson, G. G.

1932. Miocene land mammals from Florida. Bull. Fla. Geol. Surv., **10**, pp. 11–41, 23 text figures.

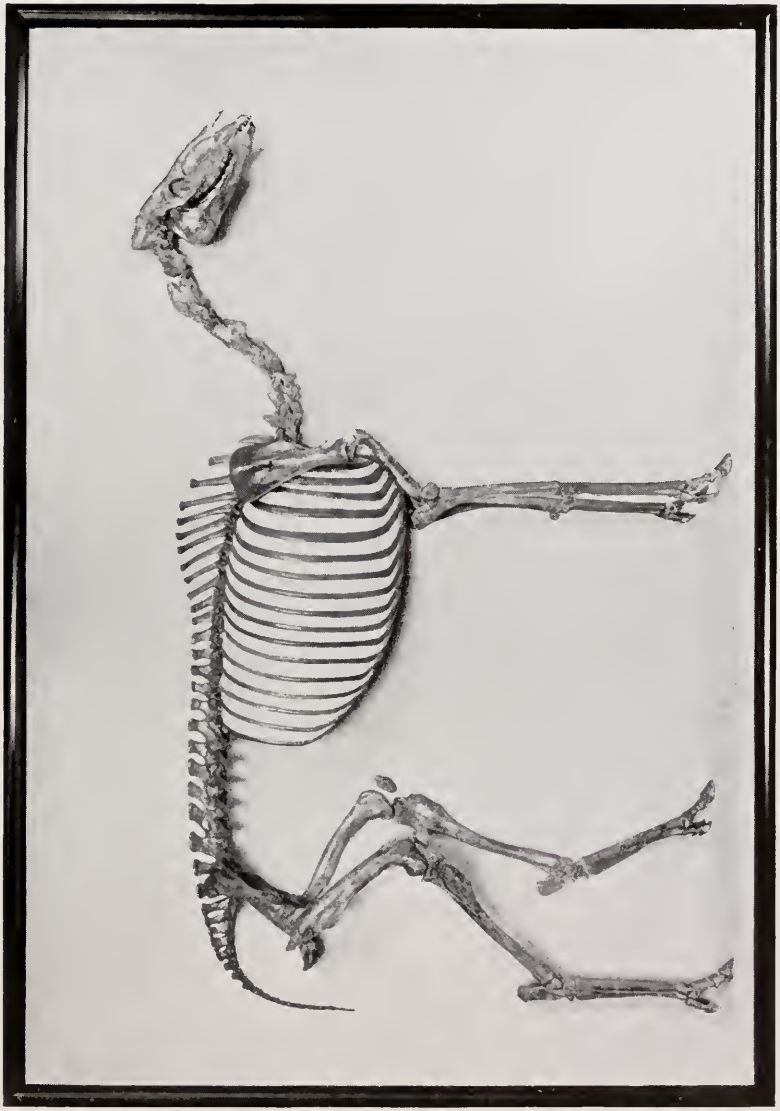
EXPLANATION OF THE PLATE

PLATE

Parahippus wyomingensis Schlaikjer

Type M. C. Z. No. 6,390. Mounted skeleton. One-fourteenth natural size.

Skeleton mounted by George Nelson.
Photograph by George Nelson.



Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
Vol. LXXX, No. 6

THE WEST INDIAN SPECIES OF OSORIUS (COLEOPTERA: STAPHYLINIDAE)

By P. J. Darlington, Jr.

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
June, 1937

No. 6 — *The West Indian Species of Osorius*
(Coleoptera: Staphylinidae)

By P. J. Darlington, Jr.

The genus Osorius, of the family Staphylinidae, is remarkable for its similarity in distribution and habitat to the genus Colpodes of the Carabidae. Both genera are well developed in the warmer parts of both hemispheres. Their distribution is not continuous, however, for both are absent over large portions of the north temperate zone. Their discontinuous distribution, as well as the fact that both are well represented in such primitive faunal regions as Madagascar and the isolated mountains of the Antilles, suggest that both genera are of ancient origin and distribution. Both are predaceous, and, although the smaller species of Osorius lead a Bledius-like existence in the sandy banks of streams, most of the larger ones that I have collected, like most species of Colpodes, occur in rotting logs and thick leaf mold in damp forest. It has been, in fact, while searching for Colpodes that most of my specimens of Osorius have been obtained. In the West Indies both genera are conspicuous members of the relict or partly endemic ground fauna of the isolated patches of cloud forest on the higher mountain ranges. They are therefore of very great interest zoögeographically, and it is for this reason that I have departed from my usual practice of leaving Staphylinidae strictly to others, and offer here a brief review of the species of Osorius known to occur in the West Indies. Colpodes will be treated in another paper.

The original material upon which this paper is based consists of 83 specimens in the Museum of Comparative Zoölogy. Of these, 81 were secured by myself from August to November, 1934, during a collecting trip made possible by grants from the Milton Fund and the Atkins foundation of Harvard University. Most of my time was spent in Haiti, but short visits were made also to Cuba and Jamaica. The other two specimens are one from Cuba collected by N. A. Weber and one from Haiti collected by W. M. Mann. A few additional specimens, including paratypes of several previously described species, have been borrowed from the United States National Museum through the kindness of Dr. E. A. Chapin, who has also compared specimens for me with the unique types of several other species, and I have been able to examine a few specimens in the American Museum through the kindness of Mr. A. J. Mutchler.

The review of American Osorius published by Howard Notman in 1925 (Proc. U. S. Nat. Mus., Vol. 67, Art. 11) has been a useful basis for the present work. Almost all the larger West Indian species fall into a group characterized by having the side margins of the prothorax broadened basally and the front margin of the clypeus crenulate (*cf.* couplets 8 and 44 in Notman's key). This group is a more or less natural one and is apparently confined to the West Indies, a fact which has greatly simplified my characterization of species. The smaller Osorius, with the side margins of the prothorax fine throughout and the clypeus not crenulate, are more difficult to define. They usually occur at lower altitudes and sometimes have wide ranges.

In addition to the characters used by Notman in his review, I have noticed two which seem very promising in grouping the species. One is the texture of the labrum, which is usually entirely alutaceous in the larger species (except *hirtilabris*) but smooth and shining with alutaceous sculpture only at the sides in the smaller forms. The other is the arrangement of the setigerous punctures on the front face of the front tibia. These punctures in some species are scattered over the entire face of the tibia, in others are arranged in a single orderly series, and in still others are confined to the apex of the tibia. It should be noted that the number and arrangement of setigerous punctures on the disk of the elytra and on the base and lateral impressions of the pronotum are often very variable in the larger, smoother species, and must be used cautiously as specific characters. Some species of Osorius are peculiarly liable to adventitious impressions on the disk of the pronotum. Such impressions are often conspicuous, bilaterally symmetrical, and very natural looking, but mean absolutely nothing taxonomically.

Although I at first drew my descriptions in the form used by Notman, I later changed them all to what seems to me a simpler and more natural pattern, which takes up the characters in the following sequence: Relative form; color. *Head:* width across eyes in terms of greatest width prothorax; size and prominence of eyes; form of clypeus; form, texture, and setae of labrum; incrassation of 5 outer antennal joints, and proportions of joints 2 & 3; texture (due to presence or absence of alutaceous sculpture) and punctulation of surface of head; occurrence of coarse punctures (usually at sides of clypeus and vertex); granules over eyes. *Prothorax:* form; width in terms of length; base in terms of apex between angles; form and sinuation of sides; form of basal and apical angles; lateral, basal, and apical margins; lateral and median (if any) impressions of disk; texture, punctu-

lation, and punctuation of surface, noting coarse setigerous punctures near base and in lateral impressions, and presence of median smooth stripe, if any. *Elytra:* width in terms of greatest width prothorax; length in terms of width; form of sides; form of humeri; impression and margining of suture; texture and punctulation of surface; discal setigerous punctures (submarginal ones need not be mentioned, are always present); texture of epipleurae. *Abdomen:* texture and punctuation above and below, noting (above) median smooth stripe (if any) and special sculpture (if any) of last 3 segments and (below) special sculpture (if any) of last 2 segments. State of inner wings. Form of prosternal tubercle, if not normally prominent and rounded. Arrangement of setigerous punctures of front face front tibia. Length and width in mm. Type and other material, with data. Discussion, if key characterization not sufficient.

All my descriptions of proportions of the head and body are based upon actual measurements made with a ruled ocular in a binocular microscope. There is not much excuse nowadays for guessing at relative measurements. Such guesses can be astonishingly inaccurate.

I do not know of any external characters distinguishing the sexes of Osorius.

Among my localities only one needs special mention. "The northeastern foothills of the Massif de la Hotte" refers to the region north of Camp Perrin and east of Desbarrières, in the southwestern peninsula of Haiti, as shown on the map of Haiti published by the *Bureau des Travaux Publiques* in 1928. This is equivalent to the region extending from Mt. La Hotte (sometimes called Pic de Macaya) 16 or 18 km. east and 5 or 6 km. north.

The types of all new species described in this paper are in the Museum of Comparative Zoölogy.

Key to West Indian species of Osorius

1. Entire front margin of clypeus crenulate; size 5—15 mm.....2
   Front margin of clypeus smooth, except sometimes denticulate near angles; 2½—9½ mm.....14
2. Anterior angles of clypeus conspicuously produced; joints 2 & 3 of antennae equal, slightly longer than wide; side margins of prothorax not broader basally; 7½ mm.....*biarmatus* n. sp.
   Angles of clypeus not produced; 3rd antennal joint much longer than 2nd, about twice as long as wide; side margins of prothorax slightly or (usually) much broader basally.....3

3. Abdominal segments (except last 2) not punctate dorsally except for anterior and posterior marginal series of punctures; anterior face front tibia with punctures not in single series.....4
Abdomen punctate dorsally; punctuation of front tibia variable 7
4. Prothorax cordate, base ¾ width apex; 14—15 mm..*regulus* n. sp.
Prothorax not cordate, base about 9/10 width apex.....5
5. Abdomen with 6th dorsal not or just visibly alutaceous.....6
6th dorsal closely, longitudinally alutaceous; 9—10 mm.....
.....*fratellus* n. sp.
6. Sides of prothorax at least slightly sinuate before base; 10—12½ mm.....*salutator* n. sp.
Sides of prothorax not sinuate; about 9 mm...*crenulifrons* Notman
7. Labrum with large, smooth, swollen area anteriorly, separated from alutaceous base of labrum by several setigerous punctures; 9—11½ mm.....*hirtilabris* n. sp.
Labrum normal, flat, alutaceous, with only marginal setae.....8
8. Front face of front tibia with setigerous punctures scattered...9
Front face of front tibia with punctures in single series.....11
9. Clypeus distinctly emarginate at middle, margin coarsely and irregularly crenate; head large, less than 1/20 narrower than prothorax; 9½ mm.....*daemon* n. sp.
Clypeus truncate and finely crenate; head narrower.....10
10. Front distinctly alutaceous; 11 mm. (see also below).....
.....*manni* Notman
Front very faintly alutaceous; 7½ mm.....*socors* n. sp.
11. Abdomen above rather openly punctate; 10½—11½ mm.....12
Abdomen above closely punctate; size smaller.....13
12. Sides of prothorax evenly arcuate from base to apex; marginal channels not conspicuous; 11 mm. (see also above).....
.....*manni* Notman
Sides of prothorax irregularly arcuate, straight for some distance before base; marginal channels relatively conspicuous; 11—11½ mm.....*cautis* n. sp.
13. Angles of clypeus not depressed; 8½ by 1⅘ mm.....
.....*mediocris* n. sp.
Angles of clypeus depressed; 4¾—7 mm.....*buscki* Notman
14. Clypeus with angles produced in prominent teeth at least ¼ as long as distance between them.....15
Clypeus with angles finely or not denticulate.....16

15. Abdomen sparsely punctate dorsally; 9½ by 2¼ mm. ..... *hubbardi* Notman
    Abdomen closely punctate dorsally except on last 2 segments; 6 by 1 1/3 mm. ..... *notmani* n. sp.
16. Prothorax slightly longer than wide (by actual measurement); 3 1/3—3 5/6 mm. ..... *eggersi* Bernh.
    Prothorax as wide as or (usually) wider than long 17
17. Length 4½—6 mm. 18
    Length 2½—3½ mm. 20
18. Angles of clypeus finely but distinctly denticulate 19
    Angles of clypeus not denticulate; 4½ mm. ..... *latipes* Grav.
19. Entire upper surface distinctly alutaceous; 5½—6 mm. ..... *schwarzi* Notman
    Head and prothorax lightly, elytra indistinctly, abdomen above not (except as usual at bases of segments) alutaceous; 4½—5 1/3 mm. ..... *haitiellus* n. sp.
20. About 3½ mm.; median smooth stripe of thorax broader 21
    About 2½ mm.; median smooth stripe subobsolete ..... *exiguus* Notman
21. Thorax as wide as elytra and equal in length, very little narrowed posteriorly ..... *micros* Sharp
    Thorax wider and slightly longer than elytra, more narrowed posteriorly and more strongly rounded basally ..... *laeviceps* Notman

Osorius biarmatus n. sp.

Slightly more slender than average, subcylindrical; black, tibiae and tarsi somewhat rufescent (body entirely rufous when immature). *Head* large, exactly as wide as greatest width prothorax; eyes small, scarcely breaking outline of sides of head; clypeus broad, anterior angles conspicuously, acutely, and somewhat divergently produced, front margin crenulate, evenly emarginate in arc of circle between apices of produced angles; labrum barely emarginate, alutaceous, setae only marginal; antennae short, faintly incrassate from the 7th joint, joints 2 & 3 equal, slightly longer than wide; surface of head faintly alutaceous (more distinctly basally) and micro-punctulate; clypeus, front, and vertex moderately punctate at sides; several small granules over eyes. *Prothorax* much narrowed basally; 1/5 or 1/6 wider than long; base ¾ or slightly less width of apex; sides slightly

and unevenly rounded, slightly sinuate at anterior 1/3 and before obtusely rounded basal angles; anterior angles not produced; lateral margins fine, not broader basally; base finely margined except at middle, apex not margined; disk broadly, faintly, longitudinally impressed before middle, sides slightly impressed contiguous to margin about ¼ before base; surface micro-punctulate but not alutaceous, moderately coarsely, not closely punctate; median stripe impunctate, not defined by distinct series of punctures. *Elytra* together wide as prothorax, 5 to 10% longer than wide, widest ¼ from apex, though nearly parallel except apically; humeri prominent but rounded; suture barely impressed, margined; surface not alutaceous but faintly roughened, shining, punctate like pronotum; epipleurae finely roughened. *Abdomen* rather closely, moderately coarsely punctate above and below except for narrow irregular dorsal smooth stripe; 6th (subapical) dorsal segment faintly alutaceous, other dorsal and last 2 ventral segments not so, very shining between punctures. Inner wings well developed. Prosternal tubercle normal. Anterior face front tibia with single series of close-set setigerous punctures. Length 7½—7¾; width 1½ mm.

Southwestern Haiti: holotype (M. C. Z. no. 20232) and 1 immature paratype from the northeastern foothills of the Massif de la Hotte, 2,000—4,000 ft., Oct. 14–24, 1934.

This is an extremely distinct species. It combines the crenulate clypeus and alutaceous labrum of most of the larger West Indian Osorius with short, slightly incrassate antennae, fine thoracic margins, and relatively close and coarse punctuation, characters found otherwise only in the group of smaller species with smooth clypeus (*cf.* couplet 1 in key).

Osorius regulus n. sp.

Large, a little stouter than average; dark castaneous to rufotestaceous (immature). *Head* large, about 9/10 as wide as prothorax; eyes small, scarcely breaking outline of sides of head; clypeus with front margin slightly convex (not emarginate), rather irregularly crenate; labrum more emarginate than usual, mostly alutaceous, but shining near front margin, setae marginal or submarginal; antennae moderately slender, not incrassate from 7th joint, joint 2 scarcely longer than wide, 3 twice as long; surface of head finely alutaceous and micro-punctulate, about 4 coarser setigerous punctures each side clypeus and a few each side vertex; a few granules over eyes. *Prothorax*

cordate, ¼ wider than long; base ¾ width apex; sides straight or slightly (sometimes irregularly) arcuate anteriorly, contracted and strongly sinuate before right or slightly obtuse, finely blunted posterior angles; apical angles slightly or not produced; lateral margins fine anteriorly, much broader posteriorly; base broadly but not deeply margined, apex indistinctly or incompletely so; disk impressed at sides basally, contiguous to margin, to 1/3 before base, also irregularly, variably, often asymmetrically impressed each side of middle in basal ½; surface alutaceous except for narrow median shining line, micro-punctulate; coarser setigerous punctures marginally (as usual), 1 in each lateral impression, and 2 groups of 3 or 4 widely scattered punctures in basal 1/3, equidistant from each other and sides. *Elytra* short, narrowed anteriorly, together about 1/10 narrower than prothorax, 1/5 or 1/6 wider than long; sides broadly nearly evenly arcuate; humeri very obtuse but humeral margins more strongly elevated than usual; suture depressed especially basally, margined; surface finely roughened; each elytron with usually 3 or 4 widely scattered discal setigerous punctures (beside usual submarginal ones), not forming a distinct median series; epipleurae only faintly alutaceous. *Abdomen* shining, barely or (apically) not alutaceous; basal segments above impunctate except for usual anterior and posterior transverse series, last 2 segments sparsely punctate except for broad median smooth area; ventral segments rather sparsely punctate except next to last (apically) and last more closely so. Inner wings reduced, not much longer than elytra, obviously useless for flight. Prosternal tubercle normal. Anterior face front tibia with numerous scattered setigerous punctures. Length 14—15 (a shriveled immature specimen 12); width 3¼—3 1/3 mm.

Southwestern Haiti: holotype (M. C. Z. no. 20233) and 5 paratypes from Mt. La Hotte, 7,000 ft. to summit (about 7,800 ft.), Oct. 16–17, 1934, in thick damp leaf mold, rotting logs, and under other cover in wet cloud forest.

In addition to being the largest West Indian Osorius, this species is the only one in which the inner wings are reduced and the humeri consequently narrowed.

Osorius crenulifrons Notman

Proc. U. S. Nat. Mus., **67**, 1925, Art. 11, pp. 9 (key) & 18.

Western Cuba: this species is known only from the unique type in the United States National Museum, from "San Diego, Cuba," taken

by Wm. Palmer, February 1, 1917. There are several Cuban towns named San Diego, but this may be presumed to be San Diego de los Baños, Pinar del Rio, for the report of the U. S. N. M. for 1917 credits Palmer with collecting small mammalian remains in cave deposits "in the mountains of western Cuba," and San Diego de los Baños is a natural base for such work. Palmer had worked there on an earlier trip, in 1900.

For comparative remarks concerning this species see under the following one.

Osorius salutator n. sp.

Form average; black, appendages slightly rufescent, tarsi paler. *Head* 4/5 width of prothorax; eyes moderate, very slightly prominent; clypeus truncate, front margin crenulate or irregularly about 8—10 serrate; labrum slightly emarginate, alutaceous, setae marginal; antennae moderately slender, not incrassate from 7th joint, joint 2 a little longer than wide, 3 twice as long; surface of head finely alutaceous, finely and rather sparsely punctulate, a few coarser punctures on clypeus and vertex especially toward sides, a few scattered granules over eyes. *Prothorax* ¼ wider than long; base as wide as apex; sides slightly, often irregularly arcuate anteriorly, slightly convergent and more or less slightly sinuate before the right or slightly obtuse finely blunted basal angles; anterior angles normally prominent, not produced; lateral margins fine anteriorly, much broader posteriorly; base rather broadly but not deeply margined, apex faintly or incompletely so; disk with or without faint traces of median line, impressed each side contiguous to margin in basal 1/3; surface alutaceous and sparsely micro-punctulate, coarser setigerous punctures in margin (as usual), 2 to 6 in each lateral impression, and 2 or more each side in basal ¼ in areas equidistant from each other and sides. *Elytra* together very slightly (not 1/20) narrower than prothorax and very slightly shorter than wide, widest ¼ or ⅓ from apex; humeri very abrupt, right or slightly obtuse and very narrowly rounded; suture slightly impressed, margined; surface rather shining, scarcely roughened, minutely and very sparsely punctulate; 4 or more coarse setigerous punctures on each elytron in irregular, median, longitudinal series; also usual submarginal setae; epipleurae faintly alutaceous. *Abdomen* faintly alutaceous, rather shining; impunctate above except for usual transverse series near margins of segments and for sparse punctures toward sides of 6th and 7th segments; basal segments below sparsely and incom-

pletely punctate, last 2 more closely and extensively so; punctures of last tending to coalesce longitudinally. Inner wings well developed. Prosternal tubercle normal. Front face front tibia with numerous scattered setigerous punctures. Length 10—12½; width 2½—2⅗ mm.

Southeastern and northern Haiti: holotype (M. C. Z. no. 20234) and 5 paratypes from La Visite and vicinity, La Selle Range, 5,000—7,000 ft., Sept. 16–23, 1934, in thick leaf mold in wet cloud forest. Also 6 specimens, not types, from summit plateau of Mt. Basil, 4,700 ft., Sept. 9, in a similar habitat. The Mt. Basil (northern) specimens have the humeri not quite so abrupt, the lateral impressions of the pronotum and the median series of the elytra with more setigerous punctures, and the last ventral with the punctures less coalescent than in the type series. However, the differences are so slight and so inconstant that I do not think they justify even a subspecific name for the Mt. Basil form.

This species is close to the Cuban *crenulifrons* Notman (preceding), but in the latter the sides of the prothorax are not sinuate before the base and the surface of the pronotum is more shining and more distinctly punctate. The punctures from which the individual hairs arise on the abdominal tergites are less distinct in *crenulifrons*, not tending to have the margins elevated as they do in *salutator*. Finally, *crenulifrons* is a little smaller, the length being given by Notman first as 8 and then as 9 mm. For the comparative differences mentioned I am indebted to Dr. E. A. Chapin, who has very kindly compared two of my specimens with Notman's type.

Osorius fratellus n. sp.

Characters in general almost exactly the same as those of the preceding (*salutator*), the description of which applies to the present insect except as follows: form similar, but color piceous, less deep black. *Head* slightly broader, 7/8 to 9/10 width of prothorax; eyes slightly more prominent; coarse punctures at sides of clypeus few or (type) not evident. *Prothorax* same. *Elytra* together equal to or barely wider (not narrower) than prothorax, about as long as wide. *Abdomen* with 6th dorsal segment closely, longitudinally alutaceous, much duller than 5th (in *salutator* the 6th segment is barely or not detectibly alutaceous). Length 9—10; width 2 1/10—2 1/5 mm.

Southeastern and southwestern Haiti: holotype (M. C. Z. no. 20235) from Furcy, La Selle Range (probably taken at about 5,000 ft.),

W. M. Mann; 1 paratype from Tardieu, just north of the main ridge of La Hotte, 3,000 ft., Oct. 14, 1934.

The only really satisfactory character separating this species from *crenulifrons* and *salutator* is the sculpture of the 6th dorsal.

Osorius hirtilabris n. sp.

Slightly stouter than average; black or piceous, appendages rufescent. *Head* large, about 9/10 width of prothorax; eyes moderate, unusually prominent (in this genus); clypeus truncate, 10—12 (sometimes more) serrate; labrum approximately truncate with broadly rounded angles, alutaceous basally, broadly swollen and shining anterio-medially, several coarse setigerous punctures in semi-circle (concave anteriorly) behind swollen area; antennae rather slender, not incrassate from 7th joint, 2nd joint slightly elongate, 3rd twice as long as wide; surface of head finely alutaceous, punctulate, more closely and coarsely so on clypeus; numerous granules above eyes, 1 or 2 innermost, on sides of vertex, bordering coarse punctures. *Prothorax* subcordate, about 1/3 wider than long; base barely more than ¾ width of apex; sides broadly arcuate anteriorly, slightly sinuate before the right or slightly obtuse basal angles; apical angles acute and slightly produced; lateral margins fine anteriorly, much broader basally; base rather narrowly margined, apex not so, at least at middle; disk slightly impressed each side contiguous to margin in basal 1/3 and sometimes also with irregular impressions each side of middle, without distinct median line; surface not or very faintly alutaceous, conspicuously punctulate; coarser setigerous punctures marginally (as usual) and 1 or 2 in each lateral impression and on each side of base in areas equidistant from each other and sides. *Elytra* as wide as prothorax, barely (1/20 or less) longer than wide, widest 1/3 from apex; sides faintly arcuate anteriorly, more so posteriorly; humeri somewhat narrowly rounded; suture slightly depressed, margined; surface slightly roughened; setigerous punctures submarginal (as usual) and 2 to 4 discally on each elytron; epipleurae much roughened. *Abdomen* entirely closely punctate, dorsal smooth stripe narrow or subobsolete; surface between punctures not or faintly alutaceous above, distinctly so below apically and usually basally also. Inner wings well developed. Prosternal tubercle normal. Front face front tibia with setigerous punctures scattered. Length 9—11; width 2 1/6—2½ mm.

Southwestern to southeastern Haiti; holotype (M. C. Z. no. 20236) and 18 paratypes from northeastern foothills of the Massif de la Hotte,

2,000—4,000 ft., Oct. 10–24, 1934, most of them taken struggling in a pond of flood water in scrubby (formerly rain-forest) country. Also 3 specimens, not types, from Miragoane, near sea level, Oct. 30-Nov. 2, and one of maximum size (11½ by 2 9/10 mm.) from Kenskoff, Massif de la Selle, 4,000—6,000 ft., Nov. 12.

The surprising modification of the labrum is unique, at least among West Indian Osorius.

Osorius daemon n. sp.

Slightly more slender than average; black, tibiae and tarsi rufescent. *Head* large, 1/20 or less narrower than prothorax; eyes scarcely breaking outline of sides of head; clypeus narrow anteriorly, distinctly emarginate at middle, angles rounded, margin coarsely and irregularly crenate; labrum slightly emarginate, alutaceous, setae marginal; antennae moderately slender, not incrassate from 7th joint, 2nd joint slightly elongate, 3rd twice as long as wide; surface of head alutaceous and micro-punctulate, several coarser punctures each side on clypeus and vertex; few scattered granules over eyes. *Prothorax* moderately narrowed behind, 1/5 wider than long, base 4/5 width of apex; sides very slightly and irregularly arcuate, subsinuate at apical 1/3 and before obtuse but well defined basal angles; anterior angles not produced; lateral margins fine anteriorly, broader basally; base deeply but not widely margined, apex not distinctly so; disk slightly impressed at sides contiguous to margins in basal 1/3; surface moderately alutaceous and punctulate, without distinct median line; 2 or 3 coarse setigerous punctures in each lateral impression and 1 each side about 1/5 from base, equidistant from each other and sides. *Elytra* less than 1/10 narrower than prothorax, as long as wide; sides nearly parallel except converging in apical 1/3; humeri narrowly rounded; suture slightly impressed and margined; surface shining, sparsely finely punctulate; usual submarginal and 2 to 4 discal setigerous punctures on each elytron; epipleurae alutaceous. *Abdomen* above and below faintly alutaceous, moderately closely not densely punctate, last 2 ventrals more closely so; narrow dorsal stripe impunctate. Inner wings well developed. Prosternal tubercle unusually prominent, normally rounded. Front face front tibia with setigerous punctures somewhat scattered. Length 9½; width just over 2 mm.

Southwestern Haiti: holotype (M. C. Z. no. 20237) and 1 paratype from northeastern foothills of the Massif de la Hotte, 2,000—4,000

ft., Oct. 10–24, 1934. The paratype was taken more specifically at Tardieu, just north of Mt. La Hotte.

The form of the clypeus is unique among the species of Osorius known to me.

Osorius manni Notman

Proc. U. S. Nat. Mus., **67**, 1925, Art. 11, pp. 9 (key) & 19.

Eastern Cuba: I have not seen this species, which is known only from the unique type, in the United States National Museum, from Pinares, Oriente, Cuba. However, Dr. E. A. Chapin has made the comparisons necessary to place the species in my key. It has been necessary to key out the species in two ways, for both the front tibiae of the type are missing and the arrangement of the setigerous punctures is therefore unknown.

Osorius socors n. sp.

Form about average, parallel; piceous, appendages rufous. *Head* rather small, about 4/5 width prothorax; eyes moderate, slightly prominent; clypeus truncate, margin rather finely crenulate; labrum barely emarginate, alutaceous, setae marginal; antennae rather slender, not incrassate from 7th joint, 2nd joint slightly longer than wide, 3rd twice as long; surface of head faintly or not alutaceous except basally, distinctly punctulate; 1 coarse puncture each side base of clypeus and 2 or 3 each side vertex; several granules over eyes. *Prothorax* 1/10 wider than long, only slightly narrowed behind, base about 9/10 width of apex; sides very slightly and evenly arcuate except faintly sinuate before rounded-obtuse basal angles; apical angles finely denticulate; lateral margins fine, slightly broader basally; base finely indistinctly margined, apex not; disk impressed at sides contiguous to margin in basal 1/3; surface not alutaceous, strongly punctulate except for inconspicuous median smooth line; a setigerous puncture in each lateral impression and 1 each side near base equidistant from each other and sides. *Elytra* as wide as prothorax and as long as wide; sides nearly parallel, slightly converging at base and apex; humeri narrowly rounded; suture scarcely impressed, margined; surface faintly roughened, rather shining; few discal setigerous punctures; epipleurae scarcely roughened. *Abdomen* above and below not distinctly alutaceous, rather finely not densely punctate, 6th dorsal more sparsely, last 2 ventrals not more closely so; dorsal impunctate stripe narrow, incon-

spicuous. Inner wings probably well developed. Prosternal tubercle normal. Front face front tibia with setigerous punctures scattered. Length 7½; width not quite 1¾ mm.

Central Cuba: holotype (M. C. Z. no. 20238) unique from Central Soledad, near Cienfuegos, Santa Clara, July, 1933, N. A. Weber. Taken with a Berlese funnel near "Harvard House."

Dr. E. A. Chapin has been kind enough to compare this specimen with the type of *manni* Notman, so that the difference in sculpture of the head used in the key has been determined by actual comparison.

Osorius cautis n. sp.

Slightly more slender than average; black or piceous, tarsi pale. *Head* rather large, about 8/9 width prothorax; eyes rather small, only slightly prominent; clypeus truncate, front margin about 10-crenulate; labrum slightly emarginate, alutaceous, setae marginal; antennae rather slender, not incrassate from 7th joint, joint 2 slightly elongate, 3 at least twice as long as wide; surface of head alutaceous and finely punctulate, 1 or more coarse punctures each side near base of clypeus and sides of vertex; several granules over eyes. *Prothorax* about 1/7 wider than long, moderately narrowed behind, base 4/5 to 6/7 wide as apex; sides very slightly, irregularly arcuate, nearly straight a little behind apex and before obtuse but very narrowly rounded basal angles; apical angles slightly produced; lateral margins fine anteriorly, broader posteriorly; base rather narrowly margined, apex not distinctly so at least at middle; disk without distinct median line, slightly impressed at sides contiguous to margins in basal 1/3; surface finely alutaceous and punctulate; 1 setigerous puncture in each lateral impression and 1 each side near base equidistant from each other and sides, also often variable punctiform (but not setigerous) impressions on disk. *Elytra* as wide or very slightly wider than prothorax, as long as wide, widest about 1/3 from apex, only a little narrowed basally; suture slightly impressed and margined; surface shining, sparsely punctulate; discal setigerous punctures on each elytron thus: 2 sub-basal (1 behind and inside of humeral umbone, 1 beside scutellum—both may be lacking), 1 at or slightly before and outside middle of elytron, 1 about 1/6 from suture in middle of length, rarely 1 or more variable accessory punctures (this is about the minimum of discal elytral setigerous punctures in any species of Osorius known to me); epipleurae somewhat roughened. *Abdomen* shining, not distinctly alutaceous; rather sparsely

punctate above, more closely but not densely so below, especially on last 2 segments; moderate median impunctate stripe dorsally. Inner wings well developed. Prothoracic tubercle normal. Front tibia with setigerous punctures of anterior face in single orderly series. Length 11—11½; width 2 1/6—2½ mm.

Southwestern Haiti: holotype (M. C. Z. no. 20239) and 6 paratypes from the summit of the ridge just above Roche Croix, on a northern spur of Mt. La Hotte, 5,000 ft., Oct. 13, 1934; 3 paratypes from Mt. La Hotte itself, 5,000 ft. to summit (about 7,800), Oct. 16–17. Taken under various ground cover in wet cloud forest.

The characters used in the key to separate this species and *manni* Notman are the result of Dr. Chapin's comparison of one of my specimens with Notman's type. I think the front tibiae of the two species will prove to be differently punctate, when those of *manni* are known.

Osorius mediocris n. sp.

Form average; black or piceous, appendages rufescent. *Head* rather small, about 6/7 width of prothorax; eyes moderate, slightly prominent; clypeus evenly truncate, crenulate; labrum scarcely emarginate, alutaceous, setae marginal; antennae rather slender, not incrassate from 7th joint, 2nd joint ½ longer than wide, 3rd about twice as long as wide; surface rather strongly alutaceous, finely punctulate, a coarse puncture each side base of clypeus; numerous granules over eyes, uppermost at each side vertex bordering a puncture. *Prothorax* 1/10—1/7 wider than long, slightly narrowed behind, base about 8/9 width of apex; sides broadly very slightly arcuate, straight or barely sinuate before the obtuse, very narrowly rounded basal angles; apical angles slightly or not prominent; lateral margins fine, broader basally; base rather finely, apex not margined; disk slightly impressed each side contiguous to margin in basal 1/3; surface finely alutaceous, distinctly punctulate except in narrow inconspicuous median stripe; a setigerous puncture in each lateral impression and 1 each side near base equidistant from each other and sides. *Elytra* together not quite as wide as prothorax, barely shorter than wide, widest 1/3 from apex, not much narrowed basally; humeri narrowly rounded; suture barely impressed, margined; surface finely roughened; minimum discal setigerous punctures; epipleurae finely roughened. *Abdomen* not distinctly alutaceous except basally below, rather finely, closely punctate throughout; no dorsal impunctate line. Inner wings well developed. Prosternal tubercle rather strong, normally rounded. Anterior face

front tibia with setigerous punctures in single series. Length 8½; width just over 1 4/5 mm.

Southeastern Haiti: holotype (M. C. Z. no. 20240) and 1 paratype from La Visite and vicinity, La Selle Range, 5,000—7,000 ft., Sept. 16–23, 1934.

Osorius buscki Notman

Proc. U. S. Nat. Mus., **67**, 1925, Art. 11, pp. 9 (key) & 19.

Hispaniola and (somewhat doubtfully) Cuba: Notman's type is from Santo Domingo without more definite locality. I found 9 specimens (one of which has been compared with the type by Dr. Chapin) in southeastern Haiti, at La Visite and vicinity, La Selle Range, 5,000—7,000 ft., Sept. 16–23, and at Kenskoff a few miles north, 4,000—6,000 ft., Nov. 12. Notman's paratype is from San Antonio de los Baños (Havana Prov.), Cuba.

The type is 4¾ mm. long as measured by Notman, while my specimens are from 5½—6½ mm. The Cuban specimen, according to Notman's key, is 7 mm. Dr. Chapin writes that it is rather different from the type. It may prove to be a different species.

Although size is most useful in distinguishing *buscki* from *mediocris* (above), there are other characters, of which the distinctly different labrum (see key) and slightly larger head (about 9/10 width of prothorax) of *buscki* should be especially noted.

Osorius hubbardi Notman

Proc. U. S. Nat. Mus., **67**, 1925, Art. 11, pp. 6 (key) & 11.

Jamaica: known only from the unique type (United States National Museum), without definite locality within the island. I have not seen the species, but it is amply distinct from description.

Osorius notmani n. sp.

Form about average; piceous or rufous, appendages rufotestaceous (both specimens immature?). *Head* moderate, 5/6 to 6/7 width of prothorax; eyes small, scarcely breaking outline of sides of head; clypeus with angles produced in conspicuous slender teeth about ¼ as long as distance between them, each tooth with a denticle at base on inner side, front margin otherwise smooth, nearly straight; labrum

scarcely emarginate, surface smooth and shining except alutaceous at sides, setae marginal; antennae average, slightly incrassate from 7th joint, 2nd joint at least ½ longer than wide, 3rd slightly longer than 2nd; surface strongly alutaceous anteriorly, faintly so on vertex; clypeus, front, and vertex with numerous rather coarse punctures at sides; granules above eyes numerous but not dense. *Prothorax* less than 1/10 wider than long, much narrowed behind, base 2/3 or 3/4 width of apex; sides broadly rounded throughout; basal angles broadly rounded, apical angles very minutely denticulate; lateral margins fine throughout; base lightly, apex not margined; disk with or without incomplete median impressed line, very slightly impressed at sides contiguous to margins in basal 1/3; surface not distinctly alutaceous, moderately coarsely not closely punctate; median stripe impunctate, not margined by distinct series of punctures. *Elytra* 1/10 or less narrower than prothorax, as long as wide, widest 2/5 from apex, slightly narrowed basally; humeri narrowly rounded; suture slightly impressed and margined; surface not alutaceous, punctate like or slightly more finely and closely than pronotum; epipleurae faintly alutaceous. *Abdomen* not distinctly alutaceous, closely punctate above and below except narrow median dorsal stripe smooth and last 2 dorsal segments sparsely and finely punctate. Inner wings well developed. Prosternal tubercle normal. Anterior face of front tibia with setigerous punctures in single slightly irregular series. Length 6; width 1⅓ mm.

Jamaica: holotype (M. C. Z. no. 20241) and 1 paratype from Main Range Blue Mts. (near Blue Mt. Peak), 5,000–7,388 ft., Aug. 17–19, 1934.

It is a pleasure to name this distinct species for Howard Notman, whose review of American Osorius has been very useful to me in writing this paper.

Osorius eggersi Bernh.

Verh. zoöl.-bot. Ges. Wien, **54**, 1904, p. 19; Notman, Proc. U. S. Nat. Mus. **67**, 1925, Art. 11, pp. 6 (key) & 22.

St. Thomas, Jamaica, Cuba, Haiti, (and Panama Canal Zone): described from the first mentioned island; recorded from Jamaica (Montego Bay), Cuba (Santiago de Cuba), and the Panama Canal Zone by Notman, whose identifications, however, must be qualified as mentioned below; in Haiti I found 1 specimen at or below Kenskoff, Massif de la Selle, 4,000 ft. or lower, Nov. 12.

The prothorax is described by Bernhauer as longer than wide, and actually is so (by 1/20) in my Haitian specimen. However, in 2 from Jamaica (borrowed from the American Museum, det. by Notman) the prothorax is as wide as long, and in 1 from the Canal Zone (borrowed from the United States National Museum, det. by Notman) it is about 1/20 wider than long (all by actual measurement). There simply is not enough material in existence to decide the relationship of these forms satisfactorily. For the time being I have placed *eggersi* in my key according to the character stressed by Notman. The identity of the specimens which do not fit the key must be considered doubtful.

Osorius latipes Grav.

Mon. Coleop. Micr. 1806, p. 198; Notman, Proc. U. S. Nat. Mus., **67**, 1925, Art. 11, pp. 8 (key) & 23.

Cuba (and United States): originally described from North America without definite locality, and now known to range widely in eastern and central United States; a specimen which I took at Soledad, near Cienfuegos, Cuba, Aug. 2–12, 1934, is apparently this species, although the head is more strongly alutaceous than usual.

Osorius schwarzi Notman

Proc. U. S. Nat. Mus., **67**, 1925, Art. 11, pp. 7 (key) & 13.

Cuba: described from 5 specimens from Cayamas, southwestern Santa Clara. One of these has been lent to me for examination from the United States National Museum.

Osorius haitiellus n. sp.

Rather small, average form; black, appendages somewhat rufescent. *Head* 9/10 width prothorax; eyes average, slightly breaking outline of sides of head; clypeus truncate in front, not crenulate, angles tridenticulate, the middle tooth at each angle much longer and more acute than the others; labrum subtruncate, smooth and shining medially, alutaceous laterally, setae marginal; antennae rather short, distinctly incrassate from the 7th joint, 2nd slightly longer than 3rd, both slightly longer than wide; surface alutaceous; clypeus, front, and vertex moderately closely and coarsely punctate at sides; numerous granules over eyes. *Prothorax* as wide or barely wider than long, moderately

narrowed behind (basal angles so rounded base cannot be accurately measured); sides faintly, often irregularly arcuate anteriorly, faintly or not sinuate before the rounded-obtuse angles; apical angles minutely or not denticulate; lateral margins fine throughout; base finely, apex not margined; disk not impressed at middle, faintly impressed at sides contiguous to margins before basal angles; surface faintly to strongly alutaceous, sparsely rather coarsely punctate; moderate median impunctate stripe bounded by rather irregular series of punctures. *Elytra* about 1/20 wider than prothorax and 1/20 longer than wide; widest 1/3 from apex, but nearly parallel; humeri narrowly rounded; suture slightly impressed, margined; surface shining but distinctly roughened, finely, rather sparsely, and indistinctly punctate; epipleurae finely roughened. *Abdomen* not distinctly alutaceous except basally below; moderately closely punctate above and below, less so on 6th dorsal, usually more closely so on last ventral where punctures sometimes tend to coalesce longitudinally; median impunctate dorsal stripe very narrow and inconspicuous. Inner wings well developed. Prosternal tubercle normal. Anterior face front tibia with setigerous punctures in single series, but series often short, confined to apical 1/2 or 1/3 of tibia. Length $4\frac{1}{2}$—$5\frac{1}{5}$; width 1 mm. (slightly more or less).

Southwestern and southeastern Haiti: holotype (M. C. Z. no. 20242) and 4 paratypes from northeastern foothills of the Massif de la Hotte, 2,000—4,000 ft., Oct. 10–24, 1934 (1 specimen more specifically from Tardieu, just north of Mt. La Hotte, Oct. 14); 1 specimen, not a type, from La Visite or vicinity, 5,000—7,000 ft., Sept. 16–23; 2, not types, from Kenskoff, a few miles north of La Visite, probably about 4,000 ft., Nov. 12.

As compared with a paratype of *Osorius schwarzi* Notman, *haitiellus* is much more shining as detailed in my key, and the denticles at the angles of the clypeus are more prominent. The setigerous punctures of the front tibiae are different, too. In *schwarzi* they are sparsely scattered over most of the length of the tibia; in *haitiellus* they are in a single more or less abbreviated series.

Osorius exiguus Notman

Proc. U. S. Nat. Mus., **67**, 1925, Art. 11, pp. 7 (key) & 16.

Cuba: described from a type and paratype (the latter loaned to me from the United States National Museum) from Cayamas, southwestern Santa Clara.

Osorius micros Sharp

Biologia Cent.-Amer., Coleop. **1**, part 2, 1887, p. 682; Notman, Proc. U. S. Nat. Mus., **67**, 1925, Art. 11, pp. 7 (key) & 22.

Cuba (and Guatemala, Honduras, and Panama): Sharp's original series came from the three Central American countries; Notman records the species from Cayamas, southwestern Santa Clara, Cuba. I have seen a specimen from Cayamas borrowed from the United States National Museum and identified by Notman.

Osorius laeviceps Notman

Proc. U. S. Nat. Mus., **67**, 1925, Art. 11, pp. 7 (key) & 15.

Puerto Rico: the unique type, which I have examined briefly in the American Museum of Natural History, is from San Juan.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
VOL. LXXX, No. 7

NOTES ON SOME SPECIES OF DRAWIDA AND PHERETIMA WITH DESCRIPTIONS OF THREE NEW SPECIES OF PHERETIMA

BY G. E. GATES
Judson College
Rangoon, Burma

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
JUNE, 1937

No. 7. — *Notes on some Species of Drawida and Pheretima with Descriptions of Three New Species of Pheretima*

By G. E. Gates

TABLE OF CONTENTS

	PAGE
Introductory Note	305
Genus *Drawida* Michaelsen 1900	306
D. barwelli (Beddard) 1886	306
D. longatria Gates 1925	309
Genus *Pheretima* Kinberg 1867	309
P. bifida sp. nov.	310
P. californica Kinberg 1867	312
P. callosa sp. nov.	313
P. copulata sp. nov.	315
P. diffringens (Baird) 1869	317
P. elongata (E. Perrier)	318
P. esafatae (Beddard) 1899	318
P. hawayana (Rosa) 1891	320
P. indica (Horst) 1883	320
P. longa (Michaelsen) 1891	321
P. montana Kinberg 1867	324
P. morrisi (Beddard) 1892	327
P. peguana (Rosa) 1890	327
P. philippina (Rosa) 1891	327
P. posthuma (L. Vaillant) 1868	329
P. sangirensis (Michaelsen) 1891	330
P. sieboldi (Horst) 1883	331
P. upoluensis (Beddard) 1887	332
P. species?	334
References	335

INTRODUCTORY NOTE

This paper presents some of the results of an examination of certain earthworms from three American museums, the Museum of Comparative Zoölogy in Cambridge, the American Museum of Natural History in New York, and the United States National Museum in Washington; and from two European Museums, the British Museum in London and Das Zoologische Museum in Hamburg. The writer is indebted to Dr. Van Name, Dr. Waldo Schmitt, Dr. C. C. A. Monro, and Dr. W. Michaelsen for the opportunity of studying the specimens from their respective institutions. To Dr. Thomas Barbour,

Director of the Museum of Comparative Zoölogy, the writer is especially indebted for the courtesy of accommodation in the museum during the winter of 1934–35.

Attention has been directed in previous papers to the advisability of dissecting off the cuticle in order to enable more accurate description of the genital markings and other external characteristics. Removal of the cuticle, may, of course, be difficult especially on hardened and brittle alcoholics. But it is often on just such specimens that important markings are rendered indistinct or even actually invisible by the presence of the cuticle. To illustrate the value of this dissection two descriptions, one written before, the other after removal of the cuticle are quoted herewith.

"The male porophores are transversely oval, not sharply demarcated and extend at least to 17/18 and 18/19" (before removal of cuticle). "The male porophores are transversely oval, slightly protuberant, definitely demarcated by a slight, circumferential furrow and extend nearly but not quite to 17/18 and 18/19" (after removal). It should be noted that exactly the same magnification and illumination was used in obtaining both of these characterizations.

Genus Drawida Michaelsen

Drawida Michaelsen 1900, Das Tierreich, **10**, p. 114. (Genotype, *Moniligaster barwelli* Beddard, 1886.)

Drawida barwelli (Beddard)

Moniligaster barwelli Beddard, Ann. Mag. Nat. Hist. Ser. 5, **17**, p. 94, 1886; Zoöl. Anz. **10**, p. 678, 1887; Quart. J. Mic. Sci., **29**, p. 119, 1888; Trans. R. Soc. Edinburgh, **36**, p. 2, 1891; Monog. of the order Oligochaeta, Oxford, p. 200, 1895 (excluding *M. beddardi*.)

Drawida barwelli Michaelsen 1900 (part), Das Tierreich, **10**, p. 116. (Excluding *M. beddardi* Rosa and *M.* species Horst.)

In 1900 when Michaelsen split off from *Moniligaster* the species with simple spermathecal atria to form the genus *Drawida*, *M. barwelli* was designated as the type of the new genus. Since that time worms from such widely separated localities as the Caroline Islands, Lombok and diverse regions of India have been referred to this species. As the genotype and also because of its unusually wide distribution (for a Drawida) the species is of considerable interest and importance.

M. barwelli was erected on a series of twenty aclitellate specimens from Manila, P. I. In the period from 1886 to 1891 all of the types were either dissected, sectioned or mounted. Whether any of these specimens are still in existence, and if so, in condition to permit study, is unknown.

At the time (1886) there was known only one other species of *Moniligaster*, *M. deshayesi* E. Perrier 1872, and from the latter, *M. barwelli* was supposed to be distinguished by the smaller size and the lack of an anterior pair of testes. Both of these distinctions are, however, of no importance at the present time. The original description furnishes the following information.

Length, not more than 1½ inch. Setae closely paired. Male pores, "two oval slit-like orifices with tumid yellowish lips which are the male generative orifices, and are situated between segments 9 and 10 between the ventral and dorsal pairs of setae." (p. 95). Four gizzards, "in one specimen at any rate." Spermathecae in vii, without atria, "opening onto the exterior in front of the outermost pair of setae" (!). Testes in ix or in septum 8/9. From figure four (pl. 3) it would appear that the vas deferens is usually short, that the male pores (?) are in *bc* slightly nearer to *b* than *c*, and that the prostates are sessile.

In a later paper ('87) Beddard again states that the male pores are in 9/10 but the spermathecal pores are now definitely placed in 6/7. The testis sacs, previously called testes, are referred to as receptacula seminis or seminal vesicles. The prostate is said to be "a small oval body," "lined throughout with a single layer of glandular looking cells, outside which are several layers of muscular fibres and outside these again peculiarly modified peritoneal cells."

In a third paper ('88) the prostate is said to have a large lumen and "the external covering is composed of numbers of large granular cells which are separated into groups by partitions." In figure 12 (pl. 12) an oviduct is shown opening to the exterior on x directly behind a seta (!).

In the fourth paper ('91) Beddard points out that he had previously failed to notice the setae of segment ii which are said to be smaller than those of succeeding segments and as a result segments i and ii had been regarded as one segment. A few additional bits of information are included in this paper. Diameter, one tenth of an inch. "The only apertures upon the outside of the body are the atrial pores in segment x" (spermathecal pores? dorsal pores?). The gizzards are now said to be three in xiv to xvi, though in figure 10 the gizzards

are in xiii to xv while "in another specimen, probably not M. Barwelli they are further back" (p. 13). The setae differ greatly in size. There are dorsal pores (!). Septa 5/6 to 8/9 are thickened. The hearts are in vi to xiv (!). The sperm sac (= testis sac) is either in ix or x or in 9/10. No trace of ovaries could be discovered. In figure 1 (pl. 25) the male pores are shown as short transverse slits on transversely oval, postsetal areas on x. In figure 7 of the same plate the prostomium is ventral to the mouth and the "supra-oesophageal ganglion" is ventral to the gut (!), or else the setae are dorsal! In figures 8 and 10 segment xi is represented as normal, *i.e.*, uncontracted to form the ovarian chamber.

The absence of an ovarian chamber and of ovisacs definitely indicates that the types were not sexually mature, while Beddard's failure to find ovaries and free ova almost as certainly shows that the types were very juvenile. In specimens too young to show rudiments of ovaries, ova, ovarian chamber or ovisacs it is scarcely probable that the male pores would be recognizable as definite apertures. At this stage they are usually represented by little more than tiny, translucent, greyish patches of the epidermis. The male porophores figured by Beddard may of course be the precociously developed rudiments of one of the invaginate types of male genital terminalia but more probably represent genital markings. At any rate there is no certainty as to what is represented.

Furthermore, in specimens so young, it is also improbable that the prostates or the spermathecae would be sufficiently developed to enable recognition of the definitive specific characteristics of these structures. The sessile conformation of the prostates and the absence of spermathecal atria can be accepted as specific characteristics only if and when the specimens are mature.

In order to define a species in the genus *Drawida* the following characteristics must be known: setal relationships, location of the male pores and characteristics of the male genital terminalia, position of the spermathecal pores, number and location of the genital markings, length of the vas deferens, shape of the central body of the prostate, type of ovarian chamber, type of genital marking glands, extent of ovisacs and characteristics of the spermathecal atria. As against this requirement, we know only that in *D. barwelli* the anterior setae are enlarged, that the spermathecal pores are in 7/8 in *cd*, and that possibly there may be two genital markings on the postsetal portion of x. None of these characteristics is of much significance except in combination with others much more important. We can be certain at present,

therefore, only of the type locality and that the specimens are referable to the genus *Drawida*. Nothing further is known of the Moniligastrid fauna of the Philippines. The species can be recognized only after the collection and study of adult topotypes.

It is at least probable that later worms referred to *D. barwelli* have had little more in common with the types of this species than a similar state of youth in which adult and hence definitive specific characteristics cannot be determined.

Drawida longatria Gates

Drawida longatria Gates 1925, Ann. Mag. Nat. Hist. ser. 9, **16**, p. 50. (Type locality, Rangoon, Burma. Type in author's collection.)

Moniligaster straeleni Michaelsen 1930, Med. K. Nat. Mus. Belg., **6**, no. 2, p. 1, and Mem. Mus. Hist. Nat. Belg., Hors Series, **2**, fasc. 5, p. 4. (Type locality, Palembang, Sumatra.)

Material examined.— From the Hamburg Museum, one softened specimen labelled, "V 11641. *Moniligaster straeleni* Mich. v. Straelen. Sumatra." This specimen, probably one of the types, had been opened and some of the internal organs, including one of the prostates, removed from the anterior end.

The male porophore, aside from the relaxation due to softening, is exactly the same as that on the types of *D. longatria*. On xii, in *bc*, there is a characteristic *longatria* genital marking.

The prostate is spirally coiled. The vas deferens passes into the extreme ental end of the prostate or very close thereto.

Remarks. M. straeleni cannot be distinguished by any characteristics of specific importance from *D. longatria*. Furthermore, the extremely elongate and slenderly tubular but simple spermathecal atria of *longatria* are quite unlike the bifid, muscular atrium, with its lobulated glandular masses, that alone distinguishes *Moniligaster* from *Drawida*.

Genus Pheretima Kinberg

Pheretima Kinberg 1867, Ofv. Akad. Förh., **23**, p. 102. (Genotype, by subsequent designation — Michaelsen, 1907, *Pheretima montana* Kinberg 1867.)

A word of explanation may be necessary with regard to the terminology used in connection with the spermathecal apertures in this

genus. The primary spermathecal pore, regardless of size, is considered to be the aperture by which the united canals of the diverticulum and the duct open to the exterior. This primary pore may be superficial, *i.e.*, at the surface of the body, or invaginate, *i.e.*, within a parietal invagination. The invagination may be confined to the body wall or may be more or less conspicuously protuberant into the coelom. If superficial the pore may be minute as in *P. diffringens* (Baird) 1869 or large as in *P. philippina* (Rosa) 1891. If invaginate the pore is usually minute.

The size of the primary pore and its method of opening to the exterior directly or indirectly through an invagination is not subject to intra-specific variation. In absence of information with regard to these points, a species cannot be fully diagnosed.

Pheretima bifida spec. nov.

Material examined.— From the Mus. Comp. Zoöl., 1 clitellate (no. 1) and 1 partially clitellate specimen (no. 2) labelled, "Ugi, Solomon Islands. W. M. Mann. No. 2027." and 2 clitellate specimens (nos 3 and 4) labelled, "Paiua, Ugi, Solomon Islands. W. M. Mann. No. 2028." All of these worms are brittle and coiled.

Length, about 100 mm. Diameter, 4 mm.

Setae are present on ii at least ventrally; the circle of xvi complete; no. 1, xvii/11, xviii/10, xix/16; no. 2, xvii/15, xviii/9, xix/12; no. 4, xvii/15, xviii/10, xix/14.

The clitellum extends from an anterior portion of xiv to the setae of xvi; on the partially clitellate specimen setae are present ventrally on xiv and xv.

The female pores are paired.

The spermathecal pores are minute and superficial; ten pairs, two pairs each in 4/5–8/9; the pores of a pair 1–2 intersetal intervals apart, the median pores of a furrow separated by a midventral distance equal to 6 to 8 intersetal intervals. On the clitellate specimen (no. 1) the lateral pore of the right side of 8/9 is lacking. On no. 4 one pore is lacking on the left side of 4/5 but there is an extra pore in 7/8 on the same side.

The male pores are minute and superficial, at the centres of transversely oval, smooth, small areas in the setal circle of xviii. Each male porophore is immediately preceded and followed by a transversely placed, slightly tumescent, whitish area, rather crescentic in shape with the concave side of the crescent facing the male porophore. The

appearance of the male pore region is somewhat similar to that of *Megascolex mauritii* (Kinberg) 1867.

The genital markings are transversely oval, paired, and presetal; on xi, xii, xvii, xix and xx (nos 1, 2 and 4). Each marking is about 2 intersetal intervals wide transversely, the preclitellar markings separated by a midventral distance equal to 2–3 intersetal intervals, the postclitellar markings by a distance equal to 5–9 intersetal intervals. On no. 4 there is an extra presetal marking on xxi on the right side. Specimen no. 3 appears to be abnormal. The left male porophore is nearly normal but the right porophore does not appear to be normally developed; the body wall is however eroded in this region. Both pairs of preclitellar genital markings are present but of the postclitellar markings there are only two, one on xvii on the right side and one on xx on the left side.

Septum 8/9 is lacking; 9/10 present but thin; 10/11 to 12/13 thickly muscular.

The intestine begins in xv (2). The intestinal caeca are simple, very short, in xxvi-xxv or xxvi-xxiv; bluntly rounded anteriorly.

The last pair of hearts is in xii (2). The single heart of ix is on the left side (2). The hearts of x are not closely bound to the anterior face of 10/11. The hearts of xi are not included within the testis sac.

The testis sac of x is U-shaped, the limbs of the U not attached to 10/11 nor enclosing the hearts of x and remarkably like seminal vesicles in their appearance. The testis sac of xi is also U-shaped, the limbs of the U reaching into the dorsal half of the segment but not to the dorsal blood vessel. The seminal vesicles of xi are included within the testis sac and surrounded by testicular coagulum. In no. 4 the vesicles are narrowed dorsally to a rod-like appendage which is curved down on itself and entirely concealed within the testicular coagulum. On the ventral margin of each of the seminal vesicles of xii is a cleft that passes dorsally, the rather slenderly columnar portion of the vesicle thus cut off is softer than the other portion of the organ and is attached by its ventral end to the posterior face of 12/13 just behind the ovary. The prostates are in xviii to xxi or xxii. The duct is C-shaped with a tiny ental quirk; thickened ectually.

The spermathecal duct is not markedly narrowed as it passes into the parietes and is shorter than the ampulla. The diverticulum passes into the body wall on the anterior face of the duct and into the duct just within the parietes, does not reach entally much beyond the middle of the ampulla and is very slenderly club-shaped. A seminal

chamber is not definitely marked off externally though the iridescence of the ental portion indicates that spermatozoa are present.

No glandular material is visible in the coelom in the region of the genital markings, the longitudinal musculature apparently uninterrupted.

Remarks. P. bifida is distinguished from *P. bleckwenni* Ude 1925 by the presence of two additional pairs of spermathecal poreslocated in 4/5, the greater size, the shortness of the clitellum, the completeness of the setal circle of xvi, the paired female pores, the numerous genital markings and their location, the absence of the hearts of xiii, and the inclusion of the anterior seminal vesicles within the posterior testis sac.

Pheretima californica Kinberg

Pheretima californica Kinberg 1867 (part), Ofv. Akad. Förh., **23**, p. 102. (Type locality, Sausolita Bay, California. Type and two paratypes from San Francisco in the Stockholm Museum.)

Material examined.— From the U. S. Nat. Mus., 1 clitellate and 1 aclitellate specimen labelled," Atuona Vall. Hivaoa. Marquesas Is. 200 ft. III.28 29. Mumford and Adamson collectors." Both specimens, from the Pacific Entomological Survey, are macerated. From the same museum, 3 clitellate specimens labelled, "Sao Paulo, Brazil. Moenkhaus. '97 or '98. No. 1318."

Length, about 100 mm. Diameter, three to five mm.

The setae begin on ii on which segment there is a complete circle. Setae formulae are as follows: — 38/viii, 49/xii, 52/xx; viii/17, xvii/22, xviii/15, xix/23; viii/17, xvii/17, xviii/13, xix/17: 44/viii, 57/xii, 61/xx; viii/19, xvii/24, xviii/17, xix/23: 39/viii, 56/xx; viii/15, xvii/19, xviii/12, xix/18: 35/viii, 51/xx; xvii/19, xviii/14, xix/17.

The first dorsal pore is in 11/12 (5).

The spermathecal pores are minute and superficial; two pairs, in 7/8–8/9.

The male pores are minute and invaginate. The apertures of the male parietal invaginations are transversely slit-shaped, the evaginations in various stages of eversion, probably in none of the specimens fully retracted. With full eversion the minute male pore is visible at the centre of a smooth, circular, disc-shaped area at the ventral end of a columnar protuberance about one half mm in diameter.

There are no genital markings.

Septa 8/9–9/10 are lacking; from 10/11 to 14/15 the opacity of the septa decreases gradually but even 10/11 is not very thick.

The intestine begins in xv. The intestinal caeca are simple, with septal constrictions and one to eight very short lobulations of the ventral margin posteriorly.

The single heart of ix is on the left side in four specimens; the remaining specimen with a pair of hearts belonging to ix. All hearts of ix to xiii pass into the ventral blood vessel; the last hearts in xiii in all five specimens. The hearts of x to xiii are bound by connective tissue to the anterior faces of septa 10/11–13/14.

The testis sacs of x and xi are unpaired and ventral. The ventral blood vessel is imbedded in the roofs of these sacs. The prostates are in xvii-xix. The prostatic duct is nearly straight or bent variously. Ectally the duct narrows and close to the parietes is bent into several short quirks which are covered over and concealed by connective tissue in such a way as to produce an appearance of a small copulatory chamber slightly protuberant into the coelom. In none of these specimens do the male invaginations actually protrude into the coelom, possibly as a result of partial relaxation and protrusion.

The spermathecal duct is shorter than the ampulla but its coelomic portion is actually about twice as long as at first appears, as a result of invagination into the ampulla. The duct increases in thickness passing ectally, attaining its greatest diameter at the point of entrance of the diverticulum and is then narrowed as it passes into the parietes. The diverticulum is elongately tubular, with little if any external evidence of differentiation into stalk and seminal chamber, variously coiled or looped, passing into the duct close to the parietes. In the gelatinized Marquesas specimens the seminal chamber can be distinguished by the iridescence of the contained spermatozoa while the shorter stalk portion can be recognized by its muscular sheen. It is worthy of especial note that the diverticula of the spermathecae of the aclitellate Marquesas specimen are characterized by an iridescence that usually indicates the presence of spermatozoa.

Pheretima callosa spec. nov.

Material examined. From the U. S. Nat. Mus. 1 clitellate specimen labelled, "Luzon, Benguet Province. P. I. Heights in the Oaks. Alt. 7,000 feet. E. A. Mearns. July 1907. No. 47782."

Length, 330 mm. Diameter, 16 mm.

The setae begin on ii on which segment there is a complete circle; 71/viii, 94/xii, 114/xx; vii/21, viii/23, xvii/23, xviii/13, xix/26.

The first dorsal pore is in 12/13.

The clitellum is annular and extends from 13/14 to 16/17. There are no setae. There is a single female pore on xiv.

The spermathecal pores are superficial, large, transverse slits with swollen margins, nearly 1 mm in width; three pairs in 6/7–8/9.

The male pores are invaginate, the apertures of the copulatory chambers transversely slit-like.

There are no genital markings externally.

Septum 8/9 is, apparently, represented only by a thin, transparent, ventral rudiment; 10/11–13/14 are thickly muscular; 9/10 lacking.

The intestine begins in xv. The intestinal caeca are simple, the margins smooth except for septal constrictions.

There is a pair of hearts belonging to ix. The last pair of hearts is in xiii. All hearts of ix to xiii pass into the ventral vessel.

The testis sacs of x and xi are paired and ventral. The seminal vesicles of xi and xii are relatively small, vertical bodies with a dorsal portion constricted off from the ventral lamina, the two parts of about the same diameter. The pseudovesicles of xiii are almost as large as the seminal vesicles. The pseudovesicles of xiv are fairly well developed but are smaller than those of xiii. The prostates are, relatively, rather small and are confined to xviii. The duct is straight and three to four mm. long. It passes into the roof of the copulatory chamber towards or at the median margin. The copulatory chambers are large and conspicuously protuberant into the coelom. The chamber is elongately ovoidal and easily separated, except for an anteroposteriorly flattened neck which passes to the external aperture, from the longitudinal muscular layer, within which it is partially imbedded. From the roof of the chamber there hangs down into the lumen a thickly conical penis which is about 2 mm long. The dorsal portion of the penis is firm and contains the ectal end of the prostatic duct. The ventral portion of the penis is soft and with a collapsed, flattened appearance. The tip of the penis is rather deeply cleft into two major lobes, one lateral and one median, the ventral margin of the lateral lobe marked off into three smaller lobules. The male pore has not been identified definitely but is probably represented by a small pore located in the dorsalmost portion of the cleft between the two major lips. On the anterior wall of the chamber as well as on the posterior wall there is a wide, horizontal cleft or slit at the anterior or posterior terminus of which is a circular, rather indistinctly delimited, slightly tumescent area bearing at its centre a small, slit-like to oval pore. This aperture leads into a small cavity within the thick mass of tissue that comprises

the anterior or the posterior wall of the copulatory chamber. The wall of the cavity is provided with slight rugosities and the lumen is lined with cuticle.

The spermathecal duct is stoutish and the wall is thick. The parietal portion is not narrowed and is provided with vertical rugosities internally. The coelomic portion is not sharply marked off from the longer ampulla. The diverticulum passes on the anterior face of the duct into the parietes and deep within the body wall into the duct. The diverticulum is looped in a zigzag fashion, the loops very short, the limbs of the loops in contact and bound together by connective tissue. A stalk portion is recognizable by its muscular sheen but externally is not sharply marked off from the seminal chamber which is longer than the stalk and very gradually and only slightly widened passing entally. The seminal chamber can be recognized by the iridescence of the contained spermatozoa which are present not only in the rather ovoidal terminal portion but also in one or two of the entalmost loops. The ental end of the diverticulum just reaches up onto the ampulla, and even after the loops are straightened out scarcely reaches to the tip of the ampulla. The spermathecal ampullae are filled with a whitish, flocculent material in which there are fine particles of soil. In a spermatheca which was opened there are in addition, in the ampulla, four, hard, reddish-translucent, pear-shaped objects.

Remarks. Segment xiv is filled with a brownish, granular material which does not appear to be aggregated into "brown discs." There are parasitic cysts in or on the walls of the ampullae or diverticula of all of the spermathecae.

The glands in the anterior and posterior walls of the copulatory chambers are like similarly placed glands in the copulatory chambers of *P. indica* (Horst) 1883, *P. montana* Kinberg 1867 and *P. philippina* (Rosa) 1891.

P. callosa is distinguished from *P. philippina* which it closely resembles by the larger size, the larger setal numbers, the rudimentary condition of septum 8/9, the vertically cleft tip of the penis and the binding together of the loops of the spermathecal diverticula.

Pheretima copulata spec. nov.

Material examined. From the Mus. Comp. Zoöl., 1 clitellate specimen labelled, "Ugi, Solomon Islands. W. M. Mann. No. 2026."

Length, ca. 80 mm. Diameter, 4 mm.

Setae are present on ii, at least ventrally; vi/3, vii/4, viii/5, xvii/8, xviii/4, xix/9, 4/xiv, ca. 15/xv, ca. 25/xvi.

The clitellum extends over segments xiv-xvi; setae are present on all segments ventrally; female pores paired.

The spermathecal pores are minute, transverse slits, slightly depressed but apparently superficial; four pairs, in 5/6–8/9, rather closely paired; the margins of the segments immediately about the pores slightly tumescent.

The male pores are tiny, transverse slits on the slightly protuberant and teat-like, central portions of transversely oval, whitish, glandular areas that extend nearly to 17/18 and 18/19. Each area is marked off by a slight circumferential furrow and is very slightly protuberant.

The genital markings are transversely oval and presetal, each marking with a rather broad rim sharply demarcated from a small and transversely oval central portion; two pairs, on xx and xxi. The markings are 5–7 intersetal intervals wide transversely and are separated from the opposite member of the pair by a midventral space equal to 4–7 intersetal intervals.

Septum 8/9 is lacking; 9/10 is present and rather thickly muscular.

The intestine begins in xv. The intestinal caeca are simple, in xxvii-xxiii.

The last pair of hearts is in xiii. The hearts of x are not bound closely to 10/11. There is a pair of hearts in ix.

The testis sacs of xi are ventral, paired and completely separated from each other midventrally. Each seminal vesicle of xii is provided at one side with a dorsal, rodlike appendage. The prostates are in xvii-xviii or xvi-xix. The duct is straight or slightly crescentic.

The spermathecal duct is stoutish, shorter than or about as long as the ampulla and sharply marked off therefrom. It passes into the parietes near the nerve cord without marked decrease in thickness. The diverticulum which is shorter than the duct is composed of a very short stalk and a longer, ovoidal seminal chamber and passes into the duct just at or just within the parietes. In segments vi and ix the spermathecal diverticula are simple, but in vii and viii an ental portion of each seminal chamber is constricted longitudinally so that the terminal part of the chamber is double. The appearance is very similar to that of the diverticulum of *P. zonata* Michaelsen 1922 (Cap. Zoöl. Deel, **1**, Af. 3, p. 43, fig. 13).

There is no glandular material visible in the coelom in the region of the genital markings, the longitudinal musculature apparently uninterrupted.

Remarks. A number of more or less closely related, octothecal, metandric species of *Pheretima* with spermathecal pores in 5/6–8/9 have been erected. Of these, four species, *neoguinensis* (Michaelsen) 1892, *badia* Ude 1932, *elberti* Ude 1932, and *swelaensis* Ude 1932 have no intestinal caeca. The remaining species are all provided with simple intestinal caeca and from them *copulata* is distinguished as follows: from *papua* (Rosa) 1898 by the absence of preclitellar genital markings, the presence of postclitellar genital markings, the presence of 9/10 and possibly by differences in the spermathecal diverticula; from *spectabilis* (Rosa) 1898 by the presence of postclitellar genital markings, the presence of 9/10 and the stalked spermathecal diverticula; from *spectabilis* Ude 1932 by the absence of 8/9, the presence of hearts in xiii and the paired testis sacs; from *pacifica* (Beddard) 1899 by the paired genital markings, the absence of 8/9, the presence of hearts in xiii and the bifid seminal chambers of the spermathecal diverticula; from *pacifica* Ude 1932 by the posterior intestinal caeca; from *gjellerupi* Cognetti 1914 by the absence of preclitellar genital markings, the presence of postclitellar genital markings and the simple spermathecal diverticula[1]; from *doormani* Michaelsen 1924 by differences in number and location of the genital markings, the absence of 8/9 and the presence of 9/10; from *vialis* Michaelsen 1924 by the presence of genital markings and the single diverticulum on each spermatheca; from *bryoni* Michaelsen and Boldt 1932 by the presence of genital markings, the absence of 8/9, the paired testis sacs and the small and bifid spermathecal diverticula; from *wetzeli* Ude 1932 by the closer pairing of the spermathecal pores, the presence of genital markings, the absence of 8/9 and the short stalk of the spermathecal diverticulum.

Pheretima diffringens (Baird)

Megascolex diffringens Baird 1869, Proc. Zoöl. Soc. London, p. 40. (Type locality, Plas Machynlleth, Montgomeryshire, North Wales. Type in the British Museum.)

Material examined. From the Mus. Comp. Zoöl., 5 clitellate specimens labelled, "Nadirivatu, Fiji Islands. W. M. Mann." and 1 clitellate specimen labelled, "St. Helena, Uplands, S. Side. 22.7.34. T. Barbour," all macerated.

[1] In *gjellerupi* Ude 1932 the seminal portion of the spermathecal diverticulum is two or three chambered.

Pheretima elongata (E. Perrier)

Perichaeta elongata E. Perrier 1872, N. Arch. Mus. Paris, **6**, p. 124. (Type locality, "Peru." Type in the Paris Museum.)

Material examined. From the U. S. Nat. Mus., 11 clitellate specimens labelled, "Batoran, Luzon. Gustav Eisen. Leon Laglouize. No. 4553," and 6 clitellate specimens labelled, "Negros Island, P. I. Bashford Dean. No. 38683." The Batoran specimens are softened.

Pheretima esafatae (Beddard)

Perichaeta esafatae Beddard 1899, In Willey, Zoöl. Res., Cambridge, part 2, p. 187. (Type locality, Esafate, New Hebrides. Holot ype, if still in existence, probably in the British Museum.)

Material examined. From the Mus. Comp. Zoöl., 1 clitellate specimen labelled, "Solomon Islands, Santa Cruz. W. M. Mann. No. 2076." From the U. S. Nat. Mus., 1 clitellate specimen labelled, "Teaotu, Hanavave Vall. Fatuhiva, Marquesas Is. 800 ft. ix.19.1930. Le Bronnec Collector," 1 aclitellate specimen labelled, "Otomahe, Oomoa Valley, Fatuhiva, Marquesas Is.," 1 clitellate specimen labelled, "Koputukea, Uapou, Marquesas Is. xi.16.30," and 1 aclitellate specimen labelled, "Vaikoao, Oomoa Vall. Fatuhiva, Marquesas Is. Aug. 29, 1930. 1600 feet. Le Bronnec Collector," all from the Pacific Entomological Survey. The M. C. Z. specimen is in good condition. The others are gelatinized.

Length, about 100 mm. Diameter, 4 mm.

The setae begin on ii. The setal formulae are as follows: — 57/-viii, 57/xii, 63/xx; viii/2, xvii/6, xviii/0, xix/7: viii/4, xvii/8, xviii/0, xix/7: viii/4, xvii/6, xviii/0, xix/7: viii/2, xvii/8, xviii/1, xix/6: viii/2, xvii/8, xviii/2, xix/9. The setae are small, closely and regularly spaced.

The first dorsal pore is in 11/12 in three specimens, on two of which this pore is definitely smaller than the pore in 12/13.

The spermathecal pores are minute, superficial, rather close to the midventral line; two pairs, in 7/8–8/9.

The male pores are superficial, tiny, transverse slits towards the median margins of transversely oval, whitish areas that are about five intersetal intervals wide transversely and which extend from the setal line to 18/19. The male pores are, accordingly, postsetal. Setae may be lacking ventrally on xviii to a point just lateral to the lateral margins of the male porophores (2 specimens). A midventral region including a posterior portion of xviii and the anterior portion of xix

may be deeply depressed, the lateral limit of the depression just beyond the lateral margin of the genital markings.

The genital markings are nearly circular, about two intersetal intervals wide and are located, on the Solomon Islands specimen, as follows: — a presetal pair each on ix and x, each marking in *bc*; on x on the right side, a presetal marking in *cd*; on xvii, one pair, each marking in *ac*; on 18/19 and 17/18 one pair each, markings just lateral to the lateral margins of the male porophores; on 19/20, three markings, two median in the region *ad* and one on the left side in *fg*; on 20/21, two markings, each in *ad*.

The genital markings of the Marquesas specimens are few and recognizable only with difficulty. On the first of these specimens there is only a tiny, circular area on 19/20, on the right side and about in *bc*. On the second specimen there is a pair of markings on 19/20, each marking in *ac*. There are no genital markings on the third and fourth specimens. On the third specimen the male pore areas are shaped like four-leaf clovers and the margins are very definitely demarcated by massed flecks of a pigment that is lacking on the porophore.

Septa 8/9–9/10 are lacking; none greatly thickened.

The intestine begins in xvi, posteriorly in xv, or with 15/16. The intestinal caeca are simple, reaching into xxi, xx or xix; with two, three or seven very short lobes of the ventral margin posteriorly.

The single heart of ix is on the right side in three specimens, on the left side in one specimen. The last pair of hearts is in xiii (4 specimens). The hearts of x are not as closely bound to 10/11 as in *upoluensis*.

The testis sacs of both x and xi are paired and ventral. The seminal vesicles of xi are small and vertical and are excluded from the posterior testis sacs. The prostates extend through xvi or xvii to xviii. The prostatic duct is about three mm long, straight except for a tiny ental quirk concealed by connective tissue. The straight portion of the duct is spindle shaped. The duct appears to pass into the parietes just anterior to septum 18/19.

The spermathecal duct (Solomon Islands specimen) is not notably narrowed until deep within the parietes. The diverticulum passes into the duct just above the parietes and comprises a stalk with a muscular sheen bent into one or two very short loops, an indistinctly marked off, slightly wider, more or less moniliform middle portion that is slightly constricted off from a terminal, spheroidal seminal chamber.

In the Marquesas specimens the duct is 1½ to 2 times as long as the ampulla, stoutish, abruptly narrowed only deep within the parietes.

The diverticulum which passes into the middle portion of the coelomic part of the duct comprises a stalk with muscular sheen that is bent into one or two very short, close loops, a slightly wider, middle portion that lacks the muscular sheen and which is constricted off from a small, terminal, spheroidal seminal chamber (?) of about the same thickness as the middle portion. In the Koputukea specimen there is no spermatozoal iridescence in any of the spermathecae but the seminal chamber of each diverticulum is occupied by a yellow, transparent, hard, spheroidal body.

The genital marking glands are sessile on the parietes, the ducts confined to the body wall.

Remarks. The Vaikoao specimen is abnormal, lacking the prostates and the anterior pair of spermathecae. The posterior spermathecae are rudimentary.

Michaelsen (1913, p. 267) has suppressed both *csafatae* and *upoluensis* which are regarded as synonyms of *P. taitensis* (Grube) 1866. Our knowledge of all of these forms is very fragmentary. *P. upoluensis* (*q.v.* hereinafter) can probably be distinguished from *csafatae* by a number of characteristics which are too important and too numerous to be regarded as individual or even subspecific variations. The suppression of *upoluensis* cannot therefore be accepted, at least at the present time. There is even less justification for the suppression of *csafatae*. *P. taitensis* is known only from one type which has, apparently, never been dissected. The fusion of two species of earthworms, especially in the genus *Pheretima*, when the internal characteristics of one of the species are entirely unknown cannot be justified at present.

Pheretima hawayana (Rosa)

Perichaeta hawayana Rosa 1891, Ann. Hofmus. Wien, **6**, p. 396. (Type locality, "Insel Haway." Types in the Vienna Museum.)

Material examined. From the Mus. Comp. Zool., 1 clitellate specimen labelled, "Nadarivatu, Viti Levu, Fiji Islands. W. M. Mann." From the U. S. Nat. Mus., 3 clitellate specimens labelled, "Sao Paulo, Brazil. Moenkhaus."

Pheretima indica (Horst)

Megascolex indicus Horst 1883, (part) Notes Leyden Mus., **5**, p. 186. (No type locality specified. Types from three localities in Sumatra and from Java. Types with copulatory chambers only.)

Material examined. From the Mus. Comp. Zoöl. 1 clitellate specimen labelled, "Moluccas, Obi Is., Lawoei. Thomas Barbour coll. 1906–07. No. 2030." and 1 clitellate specimen labelled, "Fiji Islands, Levuka, Ovalau. W. M. Mann. No. 2029." From the U. S. Nat. Mus. 1. clitellate specimen labelled, "Batoran, Luzon. P. I. Gustav Eisen. No. 4551."

Although this species is fairly old and was studied by Vaillant as far back as 1867 it has never adequately been characterized. A detailed description of specimens from Christmas Island and the Malay Peninsula is now in press.

Pheretima longa (Michaelsen)

Perichaeta longa Michaelsen 1892, Arch. Naturg., **58**, 0. 239. (Type locality, Kepahiang, Sumatra. Holotype in the Berlin Museum.)

Amyntas aeruginosus Beddard 1900 (part), Proc. Zoöl. Soc. London, 629.

Pheretima musica Michaelsen 1900, (part), Das Tierreich, **10**, p. 287.

Megascolex musicus Horst 1883 (part), Notes Leyden Mus. **5**, p. 193. (Type locality, "High mountain forests, Java." Types in Leyden Museum. The type with simple intestinal caeca only.)

Material examined. From the Mus. Comp. Zoöl., an anterior fragment of a clitellate specimen and three juveniles labelled, "Java, Sindanglaia. Thomas Barbour coll. 1906–07. No. 2025." From the U. S. Nat. Mus., 1 incomplete, clitellate specimen labelled, "Soenoeng Boender, Mt. Salak. Java Exp. O. Bryant. May 1909.," 1 clitellate specimen labelled, "Soenoeng Boender, Mt. Salak, Java. May 1909. O. Bryant. No. 50556.," and 1 incomplete, aclitellate specimen labelled, "Buitenzorg. Java Exp. O. Bryant. 5-2 1909."

Length, 295+, 305+, 297, 130+ mm. Diameter, 17, 19, 18, 12 mm.

The setae begin on ii on which segment there is a complete circle; setae small, regularly and fairly closely spaced; a slight mid-dorsal break in the setal circles. The setal formulae are as follows:—viii/26, xvii/29, xviii/20, xix/28: 71/vii, 77/ix, 76/xiii; viii/27, xvii/29, xviii/22, xix/28: 89/xiii, 83/xvii, 87/xx; viii/22, xvii/21, xviii/17, xix/28: viii/26, xvii/32, xviii/21, xix/28. There are 90 setae on the penultimate segment of one specimen. The setae, on the Soenoeng Boender specimen, are located on narrow, unpigmented bands.

The first dorsal pore is in 12/13 (1 specimen) or 13/14 (3 specimens).

The spermathecal pores are superficial, small, less than one mm.

in width, transversely slit-shaped, crescentic or oval, widely separated; two pairs, in 7/8–8/9. On the two smallest juveniles the pores are represented only by greyish translucent areas of the epidermis.

The male pores are invaginate, the apertures of the invaginations roughly circular to transversely slit-shaped, 2½ to 3 mm wide, the margins of the apertures tumescent but firm and finely wrinkled.

There are no external genital markings.

Septa 8/9 and 9/10 are lacking; septum 10/11 is very thin and in some specimens cannot be traced mesial to the hearts of x; 11/12–13/14 are thickly muscular. The seminal vesicles of xi are closely bound by connective tissue to both 10/11 and 11/12. Included within this connective tissue are the hearts of x and xi.

The intestine begins in xv. The intestinal caeca are simple and placed fairly high up in the coelom, the margins smooth except for septal constrictions.

There is a pair of hearts belonging to ix in three specimens but in one of these the right heart is smaller than the left. In one specimen there is a single heart belonging to ix, on the right side. The last pair of hearts is in xiii (4 specimens).

The testis sacs of x and xi are paired and ventral, the sacs of a pair rather widely separated midventrally. The seminal vesicles of xi and xii are rather small, relative to the size of the worm, the anterior vesicles bound to the septa by connective tissue, the posterior vesicles free. The prostates are also small and are confined to xviii except in one specimen where the prostate of one side projects slightly into xvii. The prostatic ducts are short, straight or spirally coiled. Ectally the duct appears to be thickened, almost in a conical fashion and to lack the muscular sheen but this appearance is due to the presence of connective tissue around the ectal portion of the duct. Removal of this tissue shows the duct passing directly into the body wall without intervention of a copulatory chamber. There are no glands visible in the coelom or on the parietes. The invaginations within which the male pores are contained are large and deep. The male pore is on the roof of the invagination on a small, slight protuberance that may be disc-shaped, hemispheroidal or broadly conical. On the posterior wall of the invagination there is a vertically placed, hemi-ovoidal, hard protuberance or genital marking the ventral end of which may be visible from the exterior when the aperture gapes open. The surface of the marking is smooth and glistening.

The invagination of one side of one specimen is everted and the tissues at the surface of the everted portion are eroded.

The spermathecal duct (coelomic portion) is much shorter and slenderer than the ampulla into which it may be invaginated. The duct is not narrowed as it passes into the parietes and may even be considerably widened within the body wall. The diverticulum is elongately tubular, without external demarcation into a stalk or seminal chamber, slightly flattened entally, more nearly circular in cross section ectally, apparently thickwalled but this appearance probably due, to some extent at least, to the characteristics of the seminal mass within. The diverticulum may be spirally coiled, zig-zag-looped or twisted irregularly into a compacted mass of loops and straightened out may have a length of 35 mm. The diverticulum passes into the parietes on the anterior face of the duct and at this point may be thicker than the duct. The aperture by which the diverticulum opens into the lumen of the duct is recognizable on the anterior wall after the duct has been slit open.

The largest of the juvenile specimens is 200 mm long and 14 mm thick. The setal formula is: viii/29, xvii/26, xviii/23, xix/30. The first dorsal pore is in 12/13. The male pores are not recognizable but on xviii on each side, in the setal circle, there is a transversely oval, slightly depressed, smooth area on which setae are lacking and on which the male pores are doubtless to have been developed. The spermathecal pores are recognizable as patent apertures, circular, minute, the portion of the epidermis on which the pore is located slightly depressed.

The prostates have not begun development but the seminal vesicles of both xi and xii are recognizable, the anterior vesicles already bound by connective tissue to 10/11 and 11/12. The spermathecae were not at first visible but after removal of coelomic coagulum from the floor of the coelom, four deep, well-like invaginations in the parietes with smooth margins were noted from which the tips of the ampullae of the rudiments of the spermathecae just barely project into the coelom. There are numerous small, brownish, spheroidal bodies, possibly of a parasitic origin, in the coelom of this specimen.

In one of the clitellate specimens there are brownish, disc-like bodies within the pseudovesicles of xiii and xiv. In another mature specimen the pseudovesicles of xiii each consist of a thin, translucent, membranous, dorsal sac and a slender but firm, vertical, ventral stalk by means of which the sac is attached to the posterior face of 12/13. Within each sac is a flattened "brown disc." That of the left side is 4 mm long and 2½ mm wide. The disc of the right side is smaller, only about 1½ mm long. The left sac ruptured as soon as it was

touched releasing its disc into the coelom. The pseudovesicles of xiv also contain "brown discs," smaller than those in xiii.

At least two of the mature specimens are heavily parasitized. In one of these specimens there are numbers of cysts in the parietes, each cyst ovoidal and two to three mm long. In addition there are in the coelom much larger numbers of smaller, whitish cysts. The second specimen is also characterized by the presence of these coelomic cysts but in addition there are a number of larger cysts also free in the coelom. Each of these cysts is spheroidal and transparent but with opaque, whitish material suspended in the cystic fluid.

Remarks. In *P. longa*, according to Michaelsen, the intestinal caeca are simple (einfache) while in *P. musica*, according to Horst, "the intestine is provided on each side of the 26th segment with six caeca of which the superior is the longest" as in *P. schmardae*. Rosa (1894), after examination of a single specimen from Java which was believed to be intermediate between Horst's and Michaelsen's specimens, suppressed *longa*, a procedure which was accepted by Michaelsen in 1900. Rosa, unfortunately, was unable to determine the characteristics of the intestinal caeca of his specimen and may, perhaps, have been influenced unduly by the fact that one of Horst's types of *musica* had only one pair of intestinal caecae. It is, however, extremely unlikely that any species of *Pheretima* is characterized by both simple and compound intestinal caeca. Accordingly *longa* must be reinstated. Further differences between the two species will doubtless be evident after reexamination of the types.

Horst's specimen of *P. musica* with simple intestinal caeca must be abnormal or specifically distinct from *musica* and in the latter case is probably referable to *P. longa*. There is no evidence on record to show that simple intestinal caeca may be present as an abnormality in species characterized by compound, glove-shaped caeca.

Pheretima montana (Kinberg)

Pheretima montana Kinberg 1867, Ofv. Förh., **23**, p. 102. (Type locality, "Tahiti." Type in Stockholm Museum.)

Material examined. From the U. S. Nat. Mus., 1 clitellate specimen labelled, "Tehue, Vaitaku Vall. Tahuata, Marquesas Is. May 27, 1930. 750 feet. In dead log. Le Bronnec and H. Tauraa Coll. No. 13 Olson. *P. posthuma*." 1 clitellate specimen labelled "Vaituha Valley. Eiao Marquesas Is. Oct. 3 1929. 100 feet. In damp earth under stone. A. M. Adamson Coll." 1 clitellate specimen labelled "Coconut Plantation Mohotani.

Marquesas Is. 700 + + I.31.31. Under dead log. Le Bronnec and H. Tauraa Coll.," 5 clitellate specimens labelled, "Mohotani, Marquesas Is. 700 feet. II.2.31. In soil. Le Bronnec and H. Tauraa Collectors.," and 1 partially clitellate specimen labelled, "Atuona Vall. Hivaoa. Marquesas Is. 200 feet. III.28.29. Mumford and Adamson Collectors.;" all from the Pacific Entomological Survey. The specimens are considerably softened.

Length, 80 to 100 mm. Diameter, 5 mm.

The setae begin on segment ii. The setal formulae are as follows: viii/18, xviii/7; viii/11, xvii/13, xviii/?, xix/15; viii/13, xvii/15, xviii/2, xix/15; viii/10, xvii/12, xviii/0, xix/11; viii/10, xvii/12, xviii/4, xix/14; viii/11, xvii/13, xviii/0, xix/14.

The first dorsal pore is in 11/12 or 12/13.

The spermathecal apertures are minute, crescentic or transversely slit-shaped, superficial, the margins of the apertures slightly tumescent; one pair, in 7/8.

The apertures of the copulatory chambers are large, roughly circular, gaping doubtless as a result of the maceration. On one specimen the anterior portion of a copulatory chamber is everted as a conspicuously protuberant, pear-shaped, smooth body. The tip of the penis is just barely visible at the base of the protuberance.

There are no external genital markings.

Septum 8/9 is present but membranous.

The intestine begins in xv. The intestinal caeca are simple, extending from xxvii into xxiv, xxiii or xx. The ventral margin posteriorly is provided with two to six very short lobes.

The last pair of hearts is in xiii (7 specimens). All hearts of ix to xiii pass into the ventral vessel.

The testis sacs of both x and xi are paired and ventral, the sacs of a segment fairly widely separated. The seminal vesicles of xi and xii are small, flattened, leaf-like bodies. Each vesicle is continued dorsally into a digitiform appendage. The prostate is usually in two widely separated lobes, one lobe in xvii and one in xix but either lobe may project slightly into xviii. In one specimen the prostate on the left side is in one continuous mass from which emerge five ductules that very shortly unite to form the muscular duct. The right prostate in this same specimen is in two distinct lobes. From the middle portion of the copulatory chamber arises a conspicuous, finger-shaped, laterally directed protuberance, the penis sac. This sac usually separates the two lobes of the prostate from each other. The short prostatic duct which is two to three mm in length (coelomic portion) passes into the base of the penis sac on the dorsal or median face near

the copulatory chamber. The wall of the penis sac is transparent so that the glistening prostatic duct is visible throughout its entire course to the ental end of the sac where it turns and passes into the ental end of the penis. In a considerable portion of its course through the penis sac the prostatic duct is very narrow and looped back and forth in a rather zigzag fashion. The penis is slenderly tubular, eight to nine mm in length. The copulatory chamber, from the dorsal side, has an elongately hemiovoidal appearance. The chamber reaches into xvii and xix, the portions of the chamber in these two segments not constricted or marked off from the part in xviii. The anterior as well as the posterior portion of the chamber is mainly composed of a gland with a small lumen which opens posteriorly (or anteriorly) into the lumen of the chamber by a small, circular pore at the centre of a disc-like, almost circular marking. This marking may be more or less conspicuously protuberant into the lumen of the chamber. None of the chambers are everted in the specimens examined. However, a slow, steady pull on the cuticle at the aperture of the copulatory chamber will draw the penis out to the exterior at the same time everting the central portion of the chamber. In this artificially everted condition the chamber is represented externally by a mound-like protuberance into which the ental end of the penis passes. Viewed internally, a central portion of the roof of the chamber in xviii is very deeply depressed and into this depression there pass, side by side, the prostatic duct and the penis sac.

The spermathecal duct is long and slender, perhaps two to three times the length of the ampulla but this is not immediately apparent as the duct is zigzagged on itself while the loops thus formed are covered over and concealed by connective tissue. The ampulla is bent over and bound at one side to the duct. The diverticulum is short and small, comprising an ovoidal seminal chamber and a stalk which passes into the duct close to the ampulla.

Remarks. In the Eiao specimen the left copulatory chamber is in xix rather than xviii.

The partially clitellate Atuona Valley specimen differs from the other worms as follows. The spermathecal duct is fairly short and straight, *i.e.*, not looped. No penis sacs are visible in the coelom of xviii but from the roof of the copulatory chamber there hangs down within the lumen of each chamber a thickly columnar body with a flat ventral end of circular outline. At the centre of the ventral end is a tiny pore. Within the columnar protuberance is a slenderly tubular penis about two mm in length.

Pheretima morrisi (Beddard)

Perichaeta morrisi Beddard 1892, Proc. Zoöl. Soc. London, p. 166. (Type locality supposedly Penang, but types imported to Kew Gardens. Supposed types in the British Museum are from Hongkong.)

Material examined. From the Mus. Comp. Zoöl., 1 specimen labelled, "St. Helena, Uplands, S. Side. 22.7.34. T. Barbour." From the U. S. Nat. Mus. 4 clitellate specimens labelled, "Isle of Pulo Penang. E. Deschamps. No. 41273." The M. C. Z. specimen is macerated.

Pheretima peguana (Rosa)

Perichaeta peguana Rosa 1890, Ann. Mus. Genova, **30**, p. 113. (Type locality Rangoon, Burma. Type in the Genoa Museum.)

Material examined. From the Hamburg Museum: 14 specimens in a tube labelled "V 9284 *Pheretima peguana* (Rosa). Java, Tandjong Prick Buitendyk. Mus. Leyden;" 1 specimen in a tube labelled "V 9308 *Pheretima peguana* (Rosa). Siboga Exped. Lombok Bay v. Labuan. Mus. Leyden.;" 1 specimen from a tube labelled "V 3052 *Pheretima peguana* (Rosa) Schwinghammer. Saigun;" 3 specimens in a tube labelled "V 7051 *Pheretima peguana* (Rosa) W. Wöltung H. Christopher. Batavia." and four specimens in a tube labelled "*P. rodericensis* Gr. Saigon." From the British Museum: 4 specimens in a tube labelled "*Pheretima peguana*. 1904–10–5–1357–60 Penang. coll. Beddard."; and 2 specimens from a tube labelled "*Perichaeta peguana*. 98–10–29–6. Chantaboon, Siam." From the Genoa Museum; one specimen in a tube labelled, "*Perichaeta peguana* Rosa, Ann. Mus. Civ. Genova, XXX, 1890, p. 113, T. I. f. 6–8. Typus! Rangoon, L. Fea. Cat. No. 46."

There is nothing of especial importance concerning the morphology of this worm to be added as a result of the examination of the type or of the other specimens. The species is distinct and has been adequately described. The distribution is curious: Lombok, Java, Borneo, Cochin China, Siam, Penang and Burma.

Pheretima philippina (Rosa)

Perichaeta philippina Rosa 1891, Ann. Hofmus. Wien, **6**, p. 397. (Type locality, "Insel Cebu." Types in the Vienna Museum. Known hitherto only from the types.)

Materal examined. From the U. S. Nat. Mus. 1 clitellate specimen (No. 1) labelled, "V A18 Adodolay. Md X. Balabag Silay. Occ. Negros. 12/11/29. No. 109780." and 2 clitellate specimens (No.s 2 and 3) labelled, "Negros Is. P. I. Bashford Dean. No. 38683."

Length, 197, 122 and 164 mm. Diameter, 7, 7 and 8 mm.

The setae begin on ii on which segment there is a complete circle. The setal formulae are as follows: — 36/viii, 57/xii, 53+/xx (wide dorsal gap); vii/7, viii/8, xvii/13, xviii/4, xix/16: vii/6 (+3?), viii/7 (+3?), xvii/13, xviii/6, xix/13: 40/viii, 54/xii, 64/xx; vii/9, viii/10, xvii/13, xviii/4, xix/13 (+1?). On ii–ix the setae are enlarged and conspicuously protuberant.

The first dorsal pore is in 12/13 but on one specimen there is a pore-like marking in 11/12.

The spermathecal pores are superficial, large, transverse slits nearly one mm in width; three pairs, in 6/7–8/9.

The male pores are invaginate, in copulatory chambers with large, roughly circular to transversely slit-shaped apertures slightly less than one mm in diameter, the margins of the apertures finely wrinkled and slightly tumescent. On no. 2 external to the wrinkled margin is a swollen zone which extends across 18/19 and 17/18, 18/19 lacking on the swollen areas. A copulatory chamber of no. 3 is partially everted and in such a way as to expose only the posterior wall of the chamber on which there is visible a rather mound-like protuberance of circular outline. At the centre of the protuberance is a small pit.

There are no external genital markings.

Septum 8/9 is present but thin and transparent (3 specimens); 9/10 lacking; 10/11–13/14 thickly muscular.

The intestine begins in xv. The intestinal caeca are simple and extend into xx or xxi. The margins are smooth except for septal constrictions.

The last pair of hearts is in xiii (3).

The testis sacs of x and xi are paired and ventral. Each seminal vesicle is narrowed gradually at the upper extremity into an elongately digitiform appendage. In no. 3 there is a pair of pseudovesicles in xiii. The prostates are relatively small, confined to xviii and rather crescentic in outline. The prostatic duct is two to three mm in length, U-shaped or almost straight and passes into the centre of the roof of the copulatory chamber. The latter is conspicuously protuberant into the coelom and is elongately ovoidal. From the roof of this chamber there hangs down in the lumen an elongate and slenderly conical penis. A ventral portion of the penis has a flattened, collapsed appearance and may be folded back onto the upper portion. On the median face of the penis is a very narrow, vertical groove, the margins of which are in apposition. On separation of these margins a pore,

presumably the male pore, becomes visible in the dorsalmost portion of the groove. On the anterior wall of the lumen and also on the posterior wall there is a conspicuously protuberant, hemispheroidal knob. At the centre of this knob there is a pit leading anteriorly (or posteriorly) into a small secondary lumen within the mass of tissue which forms the major portion of the anterior (or posterior) wall of the copulatory chamber. On the wall of the secondary lumen there are two to four tiny, whitish, conical or ridge-like protuberances.

The spermathecal duct (coelomic portion) is fairly thick, shorter than the ampulla, the lumen rather wide and the wall not strongly muscular but with slight vertical rugosities. In no. 2 and no. 3 the duct is covered with a macerated nephridial "fur" and is invaginated into the ampulla. The duct is not narrowed within the parietes. The diverticulum passes into the anterior face of the duct slightly ental to the parietes. The aperture of the diverticulum is recognizable as a minute pore on a slight elevation with a circular outline on the anterior wall of the lumen of the duct about half way between the external aperture and the opening into the ampulla. The diverticular stalk is slender and may reach to or even beyond the tip of the ampulla. The seminal chamber is spheroidal, ovoidal, pear-shaped or sausage-shaped and is less than one half as long as the stalk. In one specimen the diverticulum is much shorter than the combined lengths of duct and ampulla. In another specimen (no. 3) there are several slight sinuosities in the diverticular stalk.

Remarks. According to Rosa, septum 8/9 is lacking but this septum is so delicate and so transparent that it may have been unnoticed.

There are whitish cysts attached to the gut and body wall of no. 2. There is a large "brown disc" in the coelom of no. 1.

Although the external aperture of the spermatheca in this species is large, it is nevertheless the primary opening to the exterior of the combined canals of the diverticulum and duct. Hence the characterization in the preceding description of the spermathecal pores as superficial and large.

Pheretima posthuma (L. Vaillant)

Perichaeta posthuma L. Vaillant 1868, Ann. Sci. Nat., Ser. 5, **10**, p. 228. (Type locality, "Java." Types in the Paris Museum.)

Material examined. From the Am. Mus. Nat. Hist., 5 specimens labelled, "Takao, Formosa. Hans Sauter. 4.xi.07. No. A3473."

Pheretima sangirensis (Michaelsen)

Perichaeta sangirensis Michaelsen 1891, Mitt. Mus. Hamburg, **8**, p. 36. (Type locality, Sangir. Types in the Hamburg Museum.)

Material examined. From the Mus. Comp. Zoöl. two clitellate specimens labelled, "Moluccas, Halmaheira Is., Patani. Thomas Barbour coll. 1906–07. No. 2031."

The setae begin on ii on which segment there is a complete circle; viii/8–10, xvii/10–13, xviii/4–3, xix/11–13.

The spermathecal apertures are superficial, fairly large, transversely oval; one pair, in 7/8.

The apertures of the copulatory chambers are transversely slit-like and fairly closely paired.

Septa 8/9–9/10 are lacking.

The intestine begins in xv. The intestinal caeca are simple, with finger-shaped lobulations of the ventral margin.

The single heart of ix is on the left side. The last pair of hearts is in xiii.

The testis sacs of x and xi are paired and ventral, the sacs of a pair separated midventrally by the ventral blood vessel. The seminal vesicles are two pairs in xi and xii, the anterior vesicles excluded from the testis sacs of xi. The prostates are small but extend through xvii to xx. The prostatic duct is C-shaped or bent into a U-shaped loop with the limbs approximated, thickened ectally. The duct passes into the centre of the dorsal face of the copulatory chamber. The chambers are large and conspicuously protuberant into the coelom. From the roof of the chamber there hangs down within the lumen a conical penis about one mm in length. On the walls of a genital chamber there are two or three protrusions which may represent genital markings. No pores or glands connected with the supposed markings were seen, though the failure to recognize them may be due to the maceration which has taken place.

The spermathecae are in vii. The spermathecal duct is stoutish, rather barrel-shaped, nearly as thick and about as long as the ampulla, not notably narrowed within the parietes. The diverticulum comprises a small, ovoidal seminal chamber and a slender stalk of about the same length as the chamber. The latter is filled with spermatozoa. An ectal portion of the seminal chamber and the stalk are bound to the spermatheca by connective tissue. On cutting this tissue the diverticular stalk can be pulled out from a definite, vertical groove on the posterior face of the spermathecal duct. Near the parietes the stalk

passes deeper into the tissues of the duct. The spermathecal duct can be easily dissected out from the parietes and slit open to show a minute, conical papilla on the posterior wall of the lumen just anterior to the point of deeper penetration of the diverticular stalk. There are no further genital markings on the luminal wall of the duct though the wall is roughened, especially near the external aperture.

Remarks. In the coelom of the anterior end there are numerous, small, whitish cysts.

Pheretima sieboldi (Horst)

Megascolex sieboldi Horst 1883, Notes Leyden Mus., **5**, p. 191. (Type locality, "Japan." Type in Leyden Museum.)

Material examined. From the U. S. Nat. Mus. 1 aclitellate specimen labelled, "Japan. Cyrus A. Clark. No. 39562."

Length, about 250 mm. Diameter, 11 mm.

The setae begin on ii on which segment there is a complete circle; 69/viii, 74/xi, 76+/xx; vii/27, viii/27, xvii/25, xviii/15, xix/23. The setae are small, regularly and fairly closely spaced.

The first dorsal pore is in 12/13.

The external apertures of the spermathecae are small and oval; three pairs, in 6/7–8/9.

On the right side the minute male pore is superficial and on a transversely oval, smooth area. On the left side the male pore is invaginate, on the roof of a slight depression with a transversely slit-like aperture. Anterior and posterior lips are slightly tumid.

There are no genital markings.

Septum 8/9 is represented only by a ventral rudiment; 9/10 lacking.

The intestinal caeca are compound, the dorsalmost secondary caecum the longest, but the ventral secondary caeca are almost as long. The secondary caeca are bound together for some distance anterior to the point of origin by connective tissue.

There is a pair of hearts belonging to segment ix. The hearts of x and xi are included within the testis sacs.

The testis sac of x is unpaired and U-shaped, the limbs of the U reaching dorsally to the dorsal blood vessel. The testis sac of xi is cylindrical and formed by a tough sheet of tissue which passes anteroposteriorly in a cylindrical fashion from 10/11 to 11/12 enclosing the gut and all the organs of the segment. The seminal vesicles of xi

are thus included within the posterior testis sac. The prostates are confined to xviii. The prostatic duct is almost straight.

The spermathecal duct is slightly shorter than the ampulla from which it is fairly sharply marked off and is abruptly narrowed, almost to a thread, in the upper portion of the parietes. The duct can be pulled out from the body wall leaving a tiny pit on the anterior portion of a flat, oval area that is slightly depressed within the parietes. The diverticulum, without coils or loops, passes into the anterior face of the duct just within or close to the parietes and extends entally to the middle of the ampulla or to beyond the ental end of the ampulla and shows only slight evidence externally of differentiation into stalk and seminal chamber.

Remarks. The male genital terminalia are, at least on the left side, not fully developed.

The organs of segments xii-xiv had been protruded through a dorsal rupture and damaged so that certain characteristics could not be determined.

Pheretima upoluensis (Beddard)

Perichaeta upoluensis Beddard 1887, Proc. Roy. Soc. Edinburgh, **14**, p. 174. (Type locality, "Upolu Island." Types, if still in existence, are probably in the British Museum.)

Material examined. From the Mus. Comp. Zoöl., 1 clitellate specimen labelled, "Fiji Islands, Vanua Levu, Wainunu. W. M. Mann. No. 2077."

Length, about 145 mm. Diameter, 5 mm.

The setae begin on ii on which segment there is a complete circle: 70/viii, 68/xii; viii/8, xvii/10, xviii/4, xix/10.

The first dorsal pore is in 12/13.

The spermathecal apertures are tiny transverse slits; two pairs in 7/8–8/9.

The male pores are exactly in the setal line and are not readily recognizable as there is, around the pores, no apparent epidermal modification. The apertures are tiny, transverse slits the margins of which are in apposition. A slight traction is necessary on the epidermis in the vicinity of the gaps in the setal circle to separate the margins and definitely demonstrate the presence of a pore. Immediately behind each male pore is a tiny genital marking which might be mistaken for a male porophore.

The genital markings are small, nearly circular, one to two intersetal intervals wide, each with a protuberant rim and depressed centre.

The markings are located as follows: — a presetal, median marking on each of xviii and xix; a postsetal pair on xviii, immediately behind the male pores; a postsetal pair each on xvii and xix, the markings just median to the male pore lines; on the left side, a postsetal marking each on xiv, xv and xvi, each marking in line with the left postsetal marking on xvii; a postsetal pair on each of vii and viii, the markings immediately anterior to the spermathecal pores.

Septa 8/9–9/10 are lacking; 10/11–12/13 thickly muscular.

The intestinal caeca are simple and short.

The single heart of ix is on the right side. The hearts of x are bound to the anterior face of 10/11. The last pair of hearts is in xiii.

The testis sac of x may possibly be U-shaped but if so, the limbs are not filled laterally and dorsally with testicular coagulum. The testis sac of xi is U-shaped but the left limb is not normally developed. The hearts of xi are bound to the testis sac but are not included within it, at least in the dorsal half of the coelom. The seminal vesicles of xi are included within the posterior testis sac and are imbedded in the testicular coagulum. The prostates extend through xvii to xix. The prostatic duct is thick, almost straight but with an ental quirk which is concealed by connective tissue.

The spermathecal duct is not conspicuously narrowed as it passes into the parietes. The diverticulum comprises an ectal stalk portion with a muscular sheen, a middle, thinner-walled, more or less moniliform portion slightly wider than the stalk, about the same length as or shorter than the stalk, and a terminal portion, shortly ovoidal or conical and deeply constricted off from the middle portion. The diverticulum passes into the duct just at the parietes.

There are glandular masses protuberant into the coelom above the genital markings but the ducts of these glands are confined to the parietes.

The coelom of some of the post-prostatic segments is more or less filled with small, ovoidal to spheroidal, whitish, parasitic bodies. Similar bodies are also present in xiii and xiv.

Remarks. The original description of *P. upoluensis* is so incomplete that the species cannot be adequately characterized until the types have been reexamined. Although there is thus some doubt as to the identification of the specimen described above, the agreement with Beddard's description is sufficient to render inadvisable, at least for the present, the erection of a new species.

Assuming the identification to be correct, *P. upoluensis* can now be distinguished from *P. esafatae* by the location of the male pores in

the setal circle, the presence of unpaired, median, genital markings on certain segments, the unpaired testis sacs, the U-shape of the testis sacs at least of xi, and the inclusion of the anterior pair of seminal vesicles within the posterior testis sac.

In *upoluensis* the genital markings are segmental while in *esafatae* many of the markings may be intersegmental.

Pheretima species?

Material examined. One clitellate specimen from the U. S. Nat. Mus. labelled, "Japan. Rev. Cyrus A. Clark. No. 39562."

Length, about 70 mm. Diameter, 3 mm.

The setae begin on ii on which segment there is a complete circle; xvii/21, xviii/18, xix/18.

The first dorsal pore is in 12/13 but there is a pore-like marking in 11/12.

The male pores are minute, probably at the centres of disc-shaped porophores. Mesially but not laterally these porophores are depressed. On each disc are rudiments of tiny tubercles; one just anterior to, one just posterior to, and one just median to the male pore. Each of the two lateralmost male setae on each side is imbedded in a very small, whitish tubercle.

Aside from the markings just mentioned there are no other genital markings.

The intestine begins in xv. The intestinal caeca are compound, the dorsalmost secondary caecum the longest, the secondary caeca bound together by connective tissue.

There is a single heart belonging to segment ix, on the left side. No hearts belonging to x were found. The last pair of hearts is in xiii.

The seminal vesicles of xi and xii are rudimentary and flattened against the posterior faces of their septa. There is a pair of well developed (relatively) pseudovesicles in xiii. The prostates extend through segments xvi to xxi. The prostatic duct is bent into a U-shaped loop with the limbs of the loop in contact, the ectal limb thicker than the ental limb. The ducts of three coelomic glands pass into the parietes together with the prostatic duct.

There are no spermathecae.

Remarks. No parasites were to be seen either in the coelom or on the gut or the parietes.

The specimen is abnormal and possibly is to be referred to *P. yamadai* Hatai 1930. If this be correct the structures in the immediate vicinity of the male pores have not been completely developed.

REFERENCES

Michaelsen, W. 1913.
Die Oligochäten von Neu-Caledonien und den benachbarten Inselgruppen. In Sarasin and Roux, Nova Caledonia, Zoöl., **1**, lief. 3, pp. 173–280.

Rosa, D. 1894.
Perichetini nuovi o meno noti. Atti Acad. Sci. Torino, **29**, pp. 762–776.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
VOL. LXXX, No. 8

THE GENUS PHERETIMA IN NORTH AMERICA

BY G. E. GATES
Judson College, Rangoon, Burma

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
JULY, 1937

No. 8.— *The Genus Pheretima in North America*

By G. E. Gates

Pheretima, according to Stephenson (1930, p. 838) "is by far the largest genus of the Oligochaeta." It's "dominion comprehends the whole Malay Archipelago and the southeastern part of Asia with a part of Burma, China, Korea, and Japan and embraces to the southeast the Solomon Islands, the New Hebrides, and the Loyalty Islands." (Michaelsen, 1934, p. 17). Within this region, according to the same author, the genus reigns supreme, having almost completely exterminated other earthworms therein. From the area just indicated, a number of species of *Pheretima* have been widely transported, presumably by man, to other parts of the world, including both Americas.

The first American record of *Pheretima* is that of *P. californica* Kinberg 1867, with a type locality, as the name suggests, in California. By 1888 Garman had noted that "A fine species of the genus *Perichaeta* is becoming common in the hot houses of the University of Urbana" (Bull. Ill. Sta. Lab. Nat. Hist. vol. 3, p. 74). In 1896, Beddard, writing on the distribution of *Perichaeta* (= *Pheretima*) was able to state that "It is exceedingly abundant in some of the West Indian Islands, such as Trinidad, Bahamas, Grenada, Jamaica, Bermudas and Barbados." (Proc. Zoöl. Soc. London, 1896, p. 207).

Since 1896 there have been but few American records of *Pheretima* and most of these like the majority of those prior to 1896 have been the result of the study of small and quite casual collections by European oligochaetologists. Neither types nor identified specimens have been available for study in American museums. Determination of local material has been rendered still more difficult by the fact that the literature is extensive and widely scattered through a number of less familiar journals, and by the lack of a recent monograph on the genus. Thus, in 1915, Prof. Frank Smith was obliged to explain that "Because of the large number of species in the genus *Pheretima* and the consequent difficulty in determining them, *P. heterochaeta* and *P. hawayana* are not included in the key." to the earthworms of Illinois. Again, in 1928, after a discussion of the "Changes in the earthworm fauna of Illinois" (Bull. Ill. Sta. Nat. Hist. Survey, vol. 17) Prof. Smith, once more, and for the same reasons, omitted the two species of *Pheretima* from a second key.

In hope of obviating some of these difficulties work on the present paper was begun more than nine years ago, but only within the last two years has it been possible to secure access to certain important

material. The types, and (or) metatypes, or metatopotypes of nearly all of the American species have now been studied. All of the material in three of the larger American museums has been identified and that in the British Museum as well as some in certain other European museums has been examined. As a result of this work certain problems in connection with the synonymy of several species have been solved. It is however, unfortunate that earthworms have never been systematically collected in the warmer portions of the continent, in which *Pheretima* is likely to be found, for we do not yet know how many of the imported species have become definitely established within our region, how widely they have been able to spread, what ecological niches they have been able to occupy and what their role may be in supplementing or supplanting the native species.

The writer is indebted to Dr. Thomas Barbour, Director of the Museum of Comparative Zoölogy of Harvard University, for the facilities of the Museum during the period in which much of the final work on this paper was carried out, to Dr. Van Name of the American Museum of Natural History and Dr. Schmitt of the United States National Museum for the opportunity of examining the North American material in their museums, and to Dr. W. Michaelsen of the Hamburg Museum and Dr. C. C. A. Monro of the British Museum for the facilities of their respective museums as well as for assistance freely rendered on sundry other occasions.

Family MEGASCOLECIDAE

Subfamily MEGASCOLECINAE

Genus PHERETIMA

Pheretima Kinberg 1867, Ofv. Ak. Forh., **23**, p. 102. (Genotype, by subsequent designation—Michaelsen 1907, *P. montana* Kinberg 1867.)
Pheretima Michaelsen 1900, Das Tierreich, **10**, p. 234.
Perichaeta Beddard 1895, Monog. p. 388.
Amyntas Beddard 1900, Proc. Zool. Soc. London, 1900, p. 612.

Diagnosis. Setae, perichaetine. Excretory organs, exonephric and enteronephric micronephridia. A single gizzard in viii or between 7/8 and 9/10 or 10/11. Prostates, racemose. Testes and male funnels in testis sacs.

A very large proportion of the species can further be characterized as follows. The setae begin on ii on which segment there is a complete

circle. The clitellum is annular and extends from intersegmental furrow 13/14 to 16/17; with the development of the clitellar glandularity at sexual maturity the setae of the clitellar segments drop out and are not replaced, the intersegmental furrows between xiv and xv and xv and xvi disappear and the dorsal pores are occluded. The reproductive apertures are ventral; the male pores paired on xviii, one median female pore on xiv, spermathecal pores paired and symmetrical.

Septa 8/9 and 9/10 are absent or rudimentary. The intestine begins in xv or xvi close to 15/16. Holandric. Seminal vesicles are paired and free in xi and xii. The last pair of hearts is in xiii. The diverticulum passes into an ectal portion of the spermathecal duct close to or within the parietes.

Any deviation from the characteristics just mentioned requires notice in specific diagnoses.

Key to the North American species of Pheretima

1. a. Acaecal 2
   b. Caecal 3
2. a. Male pores invaginate, genital markings postclitellar only . . . . . *elongata*
   b. Male pores superficial, genital markings preclitellar and postclitellar . . . . . *taprobanae*
3. a. Quadrithecal 4
   b. Sexthecal to decathecal 7
4. a. Spermathecal pores in 5/6—6/7 . . . . . *morrisi*
   b. Spermathecal pores in 7/8—8/9 5
5. a. Intestinal caeca simple 6
   b. Intestinal caeca compound, glove-shaped . . . . . *schmardae*
6. a. Male pores invaginate, genital markings lacking . . . . *californica*
   b. Male pores superficial, genital markings present . . . . . *robusta*
7. a. Sexthecal 8
   b. Octothecal to decathecal 10
8. a. Spermathecal pores segmental . . . . . *hupeiensis*
   b. Spermathecal pores intersegmental 9
9. a. Spermathecal pores superficial, in 5/6—7/8 . . . . . *hawayana*
   b. Spermathecal pores invaginate, apertures of invaginations in 6/7—8/9 . . . . . *meridiana*
10. a. Octothecal 11
    b. Decathecal . . . . . *bicincta*

11. a. Male pores invaginate..... *posthuma*
    b. Male pores superficial..... 12
12. a. Spermathecal pores dorsal..... *rodericensis*
    b. Spermathecal pores ventral..... *diffringens*

For the benefit of those who are not familiar with the extensive systematic literature on earthworms and in particular that of the genus *Pheretima*, a few words of explanation concerning structures of taxonomic importance, of the technical terms and the descriptive or diagnostic conventions, are subjoined.

The slight boundary line between two successive segments which is usually called an intersegmental furrow is indicated by a fraction in which the numerator and the denominator are Arabic numerals representing the adjacent segments. The same convention is used to denote an intersegmental septum, the context furnishing the indication as to whether an external furrow or an internal septum is under consideration. Thus in a description of the internal anatomy, "10/11", refers to the septum separating the coelomic spaces of segments ten and eleven while in a discussion of external characteristics the same fraction refers to the furrow between segments ten and eleven. Segments are designated by small Roman numerals, thus "x" signifies segment ten.

Segments, especially in the preclitellar region, are sometimes marked off by slight furrows into secondary annuli. There is very little likelihood that secondary furrows will be confused with intersegmental furrows in the genus *Pheretima*.

The prostomium is not a structure of taxonomic importance in *Pheretima*.

Dorsal pores are sphinctered apertures in the body wall through which the coelomic fluid can be ejected. These pores are located on intersegmental furrows in the mid-dorsal line, one pore on each furrow except that pores are lacking on the anteriormost portion of the body, the first pore usually one or two segments in front of the clitellum.

Setae are numerous in the genus *Pheretima* and present in an equatorial circle around each segment, an arrangement that is termed perichaetine. Important information with regard to setal numbers in particular locations is shown in a setal formula, such as the following; "vi/13–17, xvii/20–27, xviii/10–15, xix/29–27, 65–64/xx". The first portion of this formula shows that on vi there are 13 to 17 setae ventrally between two longitudinal lines passing across the spermathecal apertures parallel to the midventral line. These setae are

called spermathecal setae. Ventral setae on xviii between the male pores are called male setae. The formula indicates that the number varies from 10 to 15. Similarly there are 20 to 27 male setae on xvii and xix, but in this case the figures show the number of setae between longitudinal lines passing across the male pores parallel to the mid-ventral line when the pores are superficial or across the centres of the apertures of the invaginations if the male pores are invaginate. If the spermathecal apertures are large or invaginate the spermathecal pore lines also pass across the centres of the apertures. When the spermathecal pores are dorsal it may be desirable to indicate the number of spermathecal setae both dorsally and ventrally, thus "vi/4–6+40–45" shows that there are 4 to 6 spermathecal setae dorsally and 40 to 45 ventrally, the spermathecal pore lines in this case taken as parallel to the mid-dorsal line. The portions of a formula with segmental numbers as denominators indicate the total number of setae on the segments mentioned, thus "56–64/xx" shows that the number of setae in the circle on xx varies from 56 to 64. Setae are always lacking on i, and may be lacking dorsally in certain species on ii, iii or even iv. Penial setae are not present in any of the American species and copulatory setae are unknown in the genus. Complete circles of setae are present on the clitellar segments of a few species, as in *taprobanae*. In other species there may be transverse rows ventrally on some or all of the clitellar segments, as in *posthuma*. Presetal and postsetal, as well as preclitellar and postclitellar hardly require explanation, their meaning is obvious. It is sometimes necessary to refer to a definite seta or intersetal interval and in such references italicized small letters are used, thus "*a*" refers to the first seta on either side of the midventral line, "*b*" refers to the second, "*c*" to the third, etc. Dorsally the first seta on either side of the mid-dorsal line is called "*z*", the second "*y*", the third "*x*", etc. Thus a male pore may be located as in line with seta *h* while a dorsal spermathecal pore may be in line with *y*. The setal nomenclature is most useful however in connection with indication of location of genital markings. Thus a genital marking may be said to be in *ab* which does not mean that the marking is actually between *a* and *b* but in the space between two lines passing across setae *a* and *b* parallel to the midventral line, the exact location of the marking indicated by qualifying terms such as pre- or postsetal or intersegmental.

Superficial and invaginate, in connection with the genital apertures scarcely require explanation. An invagination containing a genital pore may be restricted to the body wall or conspicuously protuberant

into the coelom; in the latter case, if associated with the male genital terminalia a pouch formed by the invagination is called a copulatory chamber, while a coelomic pouch associated with a spermatheca is called a spermathecal chamber. Spermathecal apertures may be minute as in *diffringens* or large as in *indica*, minute pores may be superficial or invaginate, a large pore, apparently always, superficial.

Genital markings are special areas that make their appearance externally on certain segments of an anterior portion of the body towards sexual maturity. Certain species which do not have external genital markings may have similar markings within copulatory or spermathecal chambers. The markings are usually, though not always, associated with internal glands which may be sessile on or in the body wall, or stalked and either buried in the muscular layers or protuberant into the coelom. The stalked glands always present in connection with each spermatheca of *P. meridiana* may be coelomic or imbedded within the musculature.

Length, diameter, and number of segments are usually mentioned in specific descriptions and diagnoses. There has, however, been considerable carelessness in connection with these characteristics. It should be obvious that segmental enumerations and measurements of juvenile, immature, autotomized, regenerating or regenerated specimens have no particular value so far as specific characterization is concerned. Measurements, for sake of uniformity, should be made on preserved specimens. The diameter may be measured at the region of greatest thickness, usually in or near the clitellar region.

The intestinal caeca are evaginations from the intestine, usually arising in xxvii close to 26/27 and directed anteriorly. In *bicincta* and a few other species the caeca arise in xxii. There is usually a single pair of simple caeca, each caecum more or less finger-like, sometimes constricted by the septa through which it passes, sometimes with non-segmental, slight lobulation of the ventral (or) and dorsal margin. The term compound when used in connection with intestinal caeca in this paper refers to paired, glove-shaped evaginations comprising a number of anteriorly directed, finger-like, secondary portions, each of which is roughly equivalent to a single, simple caecum. Any species of *Pheretima* is either caecal or acaecal, usually the former.

A seminal vesicle is an outgrowth from a septum, first appearing, at least in many species, as an ovoidal vesicle or ampulla attached by a ventral stalk to the posterior face of either 10/11 or 11/12. With further development the stalk broadens out into a softish, ventral lamina with which the smaller dorsal ampulla may become fused so

as to be no longer recognizable, or the dorsal ampulla may be definitely constricted off from the ventral lamina and of a distinct texture and shade. Seminal vesicles may be free or (in segment xi only) included within the testis sac or sacs.

Holandric means characterized by the presence of two pairs of testes, one each in x and xi. All the North American species are holandric.

Testis sacs are thin walled, membranous sacs enclosing the testes and male funnels. The testis sacs may be paired or unpaired. If paired each sac contains only one testis and one male funnel. If unpaired, each sac contains the two testes and two male funnels of a segment. Paired sacs may be ventral and suboesophageal or vertical, i.e., extending dorsally at the sides of the gut. The seminal vesicles of xi may be included within paired, vertical sacs but are never included within paired or unpaired suboesophageal sacs. Unpaired sacs may be ventral and suboesophageal or U-shaped, horseshoe-shaped, annular or cylindrical. When the sacs are U-shaped or horseshoe-shaped the limbs of the sac extend dorsally or ventrally at the sides of the gut. An annular sac surrounds the gut completely. A cylindrical sac is formed by a sheet of tissue in form of a cylinder passing anteroposteriorly between two successive septa in such a way as to enclose practically all of the organs of the segment. If the testis sac of xi is cylindrical the seminal vesicles of that segment are always included therein. If the testis sac of xi is U-shaped the seminal vesicles may or may not be included within the dorsally directed limbs of the sac.

Spermathecae are organs in which the spermatozoa are stored after copulation. Each spermatheca comprises three parts, a sacular, thin-walled ampulla connected with the exterior by a more or less definite and usually muscular duct and opening into the duct a diverticulum which is differentiated into a stalk and a terminal chamber within which the spermatozoa are contained. The presence of spermatozoa in the terminal portion of the diverticulum, the seminal chamber, is indicated by a characteristic iridescence.

The key has been constructed almost entirely on external characteristics for sake of greater convenience. External characteristics may however be subject to considerable variation and a dissection should always be made. The most satisfactory dissection is probably that involving a mid-dorsal incision from the anterior end to the region of segment xxx. A dry dissection is preferable to a wet dissection. Care must be taken however to prevent specimens, especially alcoholics, from becoming too dry.

Identification internally of certain anterior segments has occasion-

ally been regarded as a matter of some difficulty due to the loss of certain septa and the dislocation or delicacy of some of those present. The internal segmentation, in a few species at least, has been wrongly determined. This is probably, as a rule, quite unnecessary. The female pores in *Pheretima* are always (except on very rare, abnormal specimens) on xiv and the ovaries are always one segment in front, in xiii. Having determined that the specimen is normal by reason of the location of the female pore or pores on xiv, the ovaries can then be located in the opened specimen and from the ovarian segment which is readily identified the anterior segmentation can be worked out, checking loss of septa 8/9, 9/10 or even 10/11 against segmental commissures of the circulatory system (hearts) and the setal circles which are visible on the coelomic face of the parietes.

North America, in this paper, has been taken to include not only all of the continent from Panama north but also all of the islands of the "West Indies" from which species of *Pheretima* have been reported. One South American species, at present unknown from North America but which may eventually be found to the north, has been included.

Pheretima bicincta

Perichaeta bicincta E. Perrier 1875, C. R. Ac. Sci. Paris, **81**, p. 1044. (Type locality, Luzon or Mindonoro, P. I. Types in Paris Museum.)
Amyntas bicinctus Beddard 1900, Proc. Zool. Soc. London, 1900, p. 651.
Pheretima bicincta Michaelsen 1900, Das Tierreich, **10**, p. 419.
Pheretima bicincta Michaelsen 1910, Abh. Nat. Ver. Hamburg, **27**, p. 84. (Re-examination of the types.)
Perichaeta violacea Beddard 1896, Proc. Zoöl. Soc. London, 1896, p. 208. (Trinidad and Grenada. Specimens in the British Museum.)
Amyntas violaceus Beddard 1900, Proc. Zoöl. Soc. London, 1900, p. 641.
Pheretima violacea Michaelsen 1900, Das Tierreich, **10**, p. 312.
Pheretima violacea Michaelsen 1903, Geog. Verbr., p. 100.
Pheretima violacea Cognetti 1905, Mem. Ac. Sci. Torino, **55**, p. 34.
Pheretima violacea Michaelsen 1908, Zool. Jahrb. Sup. **11**, p. 15. (St. Thomas. Specimens in the Hamburg Museum.)

Material examined. From the British Museum: 3 clitellate specimens from a tube labelled, "*Pheretima violacea* 1904.10.5.185–7. Penang. coll. Beddard."; 2 clitellate specimens from a tube labelled, "*Pheretima violacea* 1904.10.5.1375–77. Trinidad. coll. Beddard."; 4 clitellate specimens labelled, "*Pheretima violacea* 1904.10.5.188–192. Grenada. coll. Beddard."; and 7 clitellate specimens labelled,

"*Pheretima violacea* 1904.10.5.193–196. Trinidad. coll. Beddard." The Penang specimens are, presumably, the types of *violacea*.

The setae begin on ii on which segment there is a complete circle. Setal formulae: v/10, vi/10, vii/10, viii/11, xvii/10, xviii/8, xix/9; v/9, vi/11, vii/11, viii/12, xvii/11, xviii/8, xix/10; v/10, vi/10, vii/11, viii/12, xvii/10, xviii/8, xix/11; v/10, vi/11, vii/11, viii/11, xvii/11, xviii/8, xix/10; v/10, vi/10, vii/11, viii/11, xvii/11, xviii/8, xix/9.

The clitellum is annular and extends from 13/14 to just in front of the setae of xvi, complete circles of setae also present on xiv and xv; dorsal pores lacking.

The first dorsal pore is in 12/13 (5 specimens).

The male pores are minute and superficial, each pore at the centre of a small, faintly demarcated, transversely oval porophore. The female pores are paired (5) and presetal (5). The spermathecal pores are minute and superficial, 5 pairs in 4/5 to 8/9, each pore on a tiny, transversely oval tumescence.

The two genital markings on xviii are not sharply demarcated. Each marking is rather thickly crescent-shaped and so placed that the anteriormost portion is anterior to the male pore while the posteriormost portion reaches to or almost to the midventral line, with the concave side directed anteromesially. The posterior portion or horn of the crescent, reaching to 18/19, is much thicker than the anterior portion which does not reach to 17/18. The male porophore is included in the anterior horn of a marking. On a few specimens the male porophores are more clearly demarcated and here appear to separate each genital marking into two portions.

Septum 8/9 is represented only by ventral rudiments; 9/10 is complete, slightly muscular and dislocated posteriorly.

The intestine begins in xv (5). The intestinal caeca are simple, arising in xxii and extending into xxi. The ventral margin may be provided with a few very slight lobulations (4). The typhlosole begins just behind the origin of the caeca.

There is a pair of hearts belonging to ix (5); the hearts of x and xi are included within the testis sacs; the hearts of xii free; the hearts of xiii lacking.

The testis sacs of both x and xi are unpaired and horseshoe-shaped, the ventral ends of a sac separated from each other by a short space within which is the ventral vessel. The dorsal vessel is included within the testis sacs. The seminal vesicles of xi are included within the posterior testis sac. The vesicles of xii are free. The prostates are fairly large, extending through xvi-xx. The prostatic duct is J-shaped,

the ectal limb longer and thicker than the ental limb, the loop of the J directed anteriorly into xvii, with the shorter limb lateral and the larger limb median and parallel to the nerve cord.

The spermathecal duct is about as long as the ampulla from which it is not sharply marked off and is abruptly narrowed within the parietes. The diverticulum is shorter than the combined lengths of duct and ampulla, reaching entally to the base of the ampulla or only slightly more, and passing ectally into the anterior face of the duct close to the parietes. The seminal chamber is ovoidal or somewhat irregular but approximating to oval in outline and is shorter than the stalk.

In xviii there is glandular tissue sessile on the parietes above the genital markings.

Diagnosis. Decathecal, spermathecal pores minute and superficial, 5 pairs, in 4/5—8/9. Male pores minute and superficial, on porophores included within the genital markings. Genital markings crescent-shaped, 1 pair, on xviii. Setae enlarged on preclitellar segments except on x; v/9–10, vi/10–11, viii/11–12, xvii/10–11, xviii/4–8, xix/9–11; complete circles present on all clitellar segments. Clitellum terminates anterior to the setae of xvi. Length, 50–80 mm. Diameter, 2–3 mm.

Septum 9/10 present and thickened. Intestinal caeca simple, in xxii. Last pair of hearts in xii. Testis sacs of x and xi unpaired and horseshoe-shaped, hearts of x included within the anterior sac, hearts and seminal vesicles of xi included within the posterior sac. Spermathecal diverticulum shorter than combined lengths of duct and ampulla, passing into anterior face of duct, seminal chamber ovoidal or approximating to ovoidal and shorter than the stalk. Genital marking glands sessile.

Distribution. Trinidad, Grenada and St. Thomas. Little is known of the extra-American distribution of this species. It has been recorded twice from India (Trivandrum and Hyderabad, Deccan), once each from Penang, Java, and the Philippines. Its presence in Penang and India is doubtless the result of transference by man. The original home of the species may possibly be the Philippines.

Pheretima californica

Pheretima californica Kinberg 1867 (part), Ofv. Ak. Forh. **23**, p. 102. (Type locality, Sausolita Bay, California. Type and two paratypes from San Francisco in the Stockholm Museum.)

Pheretima californica Michaelsen 1900, Das Tierreich, **10**, p. 258.

Pheretima californica Michaelsen 1903, Geog. Verbr. p. 95.
Pheretima californica Cognetti 1904, Boll. Mus. Torino, **19**, #478, p. 2. (San Jose, Rancho Redondo near Cartago, Costa Rica. Specimens in Turin Museum.)
Pheretima californica Cognetti 1905, Boll. Mus. Torino, **20**, #495, p. 2. (Colon, Panama. Specimens in Turin Museum.)
Pheretima californica Cognetti 1905, Mem. Ac. Sci. Torino, **55**, p. 32.
Megascolex californicus Vaillant 1889, Hist. Nat. Annel. **3**, part 1, p. 70.
Amyntas californicus Michaelsen 1899, Ofv. Ak. Forh. **56**, p. 438. (Re-examination of types.)
Amyntas californicus Beddard 1900, Proc. Zoöl. Soc. London, 1900, p. 627.
Perichaeta ringeana Michaelsen 1890, Mitt. Mus. Hamburg, **7**, p. 10. (Type locality, Vera Cruz, Mexico. Types in Hamburg Museum.)
Perichaeta ringeana Beddard 1895, Monog. p. 419.
Perichaeta hesperidum Beddard 1892, Proc. Zoöl. Soc. London, 1892, p. 169. (Type locality, Barbados. Types in British Museum?)
Perichaeta hesperidum Beddard 1895, Monog. p. 415.
Pheretima hesperidum Michaelsen 1900, Das Tierreich, **10**, p. 315.
Pheretima hesperidum Michaelsen 1903 (part), Geog. Verbr. p. 96. (Excluding distribution of *P. löhri*.)
Pheretima hesperidum Cognetti 1905, Mem. Ac. Sci. Torino, **55**, p. 33.
Amyntas hesperidum Beddard 1900 (part), Proc. Zoöl. Soc. London, 1900, p. 633. (Excluding *P. löhri*.)

Material examined. From the British Museum, 2 clitellate specimens labelled, "*Pheretima* sp. 1904.10.5.13. Barbados. coll. Beddard." These specimens may possibly be the types of *P. hesperidum*. A number of specimens from South America, the Marquesas Islands and China have been examined. Reports on this material are being presented elsewhere.

Diagnosis. Quadrithecal, spermathecal pores minute and superficial, two pairs, in 7/8—8/9. Male pores minute and invaginate, on the roofs of invaginations with transversely slit-like apertures and cavities; invaginations eversible as shortly columnar porophores, marked internally by a more or less conspicuous protuberance into the coelom composed mainly of connective tissue and the tiny quirks of the prostatic duct. No genital markings. Setae slightly enlarged ventrally on iii–ix; viii/12–19, xvii/16–24, xviii/9–18, xix/15–23, 23–34/v, 28–40/vi, 33–40/vii, 35–48/viii, 34–46/ix, 34–44/x, 49–60/xii, 51–61/xx. First dorsal pore in 11/12. Length, 50–125 mm. Diameter, 3–5 mm. Segments, 105–112.

Intestinal caeca simple. Testis sacs of x and xi unpaired and ventral. Spermathecal duct shorter than the ampulla into which it is

invaginated; diverticulum coiled or looped, stalk much shorter than the elongately tubular seminal chamber.

Distribution. California, Mexico, Costa Rica, Panama and Barbados. In South America, Brazil and Easter Island. Elsewhere, known from Madeira, Funchal, Egypt, Hawaiian and Marquesas Islands, Queensland and China. The species is widely distributed in China and is known from Hongkong and Yunnan, Szechuan, Kiangsu, Chekiang, Anhwei, Kiangsi, Hupei and Hunan provinces, and extends from the province of Yunnan just across the border into Burma. It is possible that from this Chinese area the species has been carried elsewhere.

Pheretima diffringens

Megascolex diffringens Baird 1869, Proc. Zoöl. Soc. London, 1869, p. 40. (Type locality, Plas Machynlleth, Montgomeryshire, North Wales. Types in the British Museum.)

Megascolex diffringens Vaillant 1889, Hist. Nat. Annel. **3**, part 1, p. 75.

Pheretima diffringens Gates 1935, Lingnam Sci. J. Canton, **14**, p. 452.

Pheretima californica Kinberg 1867 (part), Ofv. Ak. Forh. **23**, p. 102. (Two paratypes from Sausolita Bay, California.)

Perichaeta indica Michaelsen 1892, Arch. Natg. **58**, p. 252. (Berlin Botanical Garden, in earth from San Domingo.)

Perichaeta indica Michaelsen 1894, Zoöl. Jahrb. Syst. **8**, p. 191. (Orvieto, Florida and Savannah, Georgia. Specimens in Hamburg Museum.)

Perichaeta indica Ude 1895, Zeit. wiss. Zoöl. **61**, p. 129. (Savannah, Georgia.)

Perichaeta indica Beddard 1895 (part), Monog. p. 427. (Excluding forms with copulatory chambers.)

Amyntas indicus Michaelsen 1899, Ofv. Ak. Forh. **56**, p. 436. (After re-examination of two paratypes of *californica*.)

Pheretima indica Michaelsen 1900, (part), Das Tierreich, **10**, p. 275. (Excluding forms with copulatory chambers.)

Pheretima indica Kindred 1929, J. Morph. **47**, p. 441. (Charlottesville, Virginia.)

Amyntas heterochaetus Beddard 1900 (part), Proc. Zoöl. Soc. London, 1900, p. 622. (Excluding *modigliani* and *nipponica*.)

Pheretima heterochaeta Michaelsen 1903 (part), Geog. Verbr. p. 96. (Excluding distribution of *modigliani* and *nipponica*.)

Pheretima heterochaeta Cognetti 1904, Boll. Mus. Torino, **19**, #462, p. 2. (Costa Rica, Chemin de Carillo, towards the Atlantic. La Palma. Cachi. Specimens in Turin Museum.)

Pheretima heterochaeta Cognetti 1904, Boll. Mus. Torino, **19**, #478, p. 2. (Costa Rica, Pianure di Santa Cruz, San Jose, Turrùcares, Rancho Redondo near Cartago. Specimens in Turin Museum.)

Pheretima heterochaeta Cognetti 1905, Mem. Ac. Sci. Torino, **55**, p. 33.

Pheretima heterochaeta Cognetti 1907, Atti Ac. Sci. Torino, **42**, p. 790. (Costa Rica, Tablazo, Tejar de Cartago. Specimens in Turin Museum.)

Pheretima heterochaeta Cognetti 1908, Atti Ac. Sci. Torino, **43**, p. 913. (Costa Rica, Santa Maria de Dota. Specimens in Turin Museum.)

Pheretima heterochaeta Smith 1915, Bull. Illinois Sta. Lab. Nat. Hist. **10**, p. 555. (Illinois.)

Pheretima heterochaeta Michaelsen 1925, Mitt. Mus. Hamburg, **41**, p. 73. (South Mexico, Finca Manacal near Tapachula. Specimens in Hamburg Museum.)

Pheretima heterochaeta Smith 1928, Bull. Ill. Nat. Hist. Survey, **17**, p. 359. (Illinois.)

Pheretima heterochaeta Stephenson 1933, Proc. Zoöl. Soc. London, 1932, p. 916. (Duke Forest, Durham, North Carolina. Specimens in British Museum.)

Material examined. From the Museum of Comparative Zoölogy: 4 clitellate specimens labelled, "3 miles east of Greensburg in Tickfaw River Valley, La. Oct. 22, 1934. S. Biol. Sup. Co. No. 2062." From the American Museum of Natural History: 1 clitellate and 2 aclitellate specimens labelled, "Gainesville, Fla. Oct. 1, 1914. F. 3616. A 5007." From the United States National Museum: 16 clitellate specimens labelled, "Auburn, Ala. D. J. Duggan. #1199"; 4 clitellate specimens labelled, "Monticello, Fla. Jan. 1–2, 1914. #1014"; 2 clitellate specimens labelled, "Macon, Georgia. A. A. Hinkley. #1027"; 5 clitellate specimens labelled, "Bermuda grass, McNeill, Miss. H. R. Reid. Spring of 1921"; 3 clitellate specimens labelled, "Ortega, Fla. May 6, 1921. J. H. McKinnon"; 1 clitellate specimen labelled, "Biscayne Bay, Fla. E. J. Brown. #45875"; 7 clitellate specimens labelled, Chapel Hill, N. C. April 7, 1925. F. E. Coker. #1261"; 11 clitellate specimens labelled, Covington, La. Aug. 24, 1915. S. Biol. Sup. Co. #58810". From the British Museum: 1 clitellate specimen from a tube labelled, "*Pheretima peregrina* 1904. 10.5.1392–3. West Indies. coll. Beddard".

One of the Tickfaw Valley specimens has postclitellar genital markings, one pair, postsetal on xviii.

Parasites. In several of the Louisiana specimens there are numbers of gregarine cysts scattered through the coelomic spaces of the postclitellar segments. One specimen has cysts attached to the diverticula of the spermathecae.

Similar gregarine parasites have been suspected of inhibiting the development of the prostate in other species of *Pheretima*.

Diagnosis. Octothecal, spermathecal pores minute and superficial, 4 pairs, in 5/6—8/9. Male pores minute and superficial, on transverse-

ly oval, disc-shaped porophores. Genital markings small, circular, disc-shaped, in six longitudinal rows on v–ix; two rows of postsetal markings each of which is just in front of a spermathecal pore and four rows of presetal markings, of which the two lateral rows are slightly median to the spermathecal pore lines, while the more median rows are approximately in *bc*. Setae enlarged midventrally on ii–ix; vi/6–11, vii/8–14, viii/10–16, xvii/13–17, xviii/9–16, xix/13–17, 26–36/vi, 37–42/viii, 42–44/xii, 42–52/xx. First dorsal pore in 11/12. Length, 45–170 mm. Diameter, 3–6 mm. Segments, 90–113.

Intestinal caeca simple. Hearts of x lacking. Testis sacs of x and xi unpaired and ventral. Spermathecal duct shorter than the ampulla; diverticulum with an ovoidal seminal chamber and a longer, slender stalk. Genital marking glands stalked and coelomic.

Variations. The setae on x may be smaller than on xi. The genital markings may be restricted to one or two pairs or may be entirely lacking on an occasional specimen. A complete set of markings in the six longitudinal rows is probably never present. Postclitellar genital markings are occasionally found, apparently always on xviii and postsetal. Preclitellar, postsetal stalked glands may be present though the corresponding genital markings may be unrecognizable externally. Prostates are often lacking or are rudimentary though the prostatic ducts are usually well developed.

Distribution. Illinois[1] (green houses only), Virginia, North Carolina, Georgia, Alabama, Florida, Mississippi, California, Mexico, Costa Rica, San Domingo. In South America, Colombia and Peru. Elsewhere, Wales, France, Portugal, Italy, Scotland (greenhouses), Poland (greenhouses), Azores, Sardinia, St. Helena, Cape Verde, Anjouan, Madagascar, Natal, Transvaal, Hawaiian Islands, Australia, New Caledonia, Sumatra, Java, Burma, India, Ceylon, China including Hongkong and the provinces of Yunnan, Szechuan, Chekiang, Kiangsi, Kiangsu, Anhwei. *P. diffringens* is probably present in Japan but just which of the inadequately described Japanese species are to be suppressed as synonyms is not evident.

Pheretima elongata

Perichaeta elongata E. Perrier 1872, N. Arch. Mus. Paris, **8**, p. 124. (Type locality, "Peru". Types in Paris Museum.)
Perichaeta elongata Beddard 1895, Monog. p. 431.

[1] In manuscript notes deposited in the United States National Museum by Prof. Frank Smith are references to *P. heterochaeta* (= *P. diffringens*) being found in greenhouses in Chicago near the end of the 19th century and in Urbana earlier than 1893.

Megascolex elongatus Vaillant 1889, Hist. Nat. Annel. **3**, part 1, p. 81.
Amyntas elongatus Beddard 1900, Proc. Zoöl. Soc. London, 1900, p. 650.
Pheretima elongata Michaelsen 1900, Das Tierreich, **10**, p. 265.
Pheretima elongata Michaelsen 1910, Abh. Nat. Ver. Hamburg, **19**, #5, p. 84. (Re-examination of the types.)
Pheretima biserialis Michaelsen 1902, Mitt. Mus. Hamburg, **19**, p. 9. (Arecibo, Puerto Rico. Specimens in the Hamburg Museum.)
Pheretima biserialis Michaelsen 1903, Geog. Verbr. p. 94.
Pheretima biserialis Cognetti 1905, Boll. Mus. Torino, **20**, #495, p. 2. (Panama. Specimens in the Turin Museum.)
Pheretima biserialis Cognetti 1905, Mem. Ac. Sci. Torino, **55**, p. 30.
Pheretima biserialis Michaelsen 1908, Zoöl. Jahrb. Sup. **11**, p. 14. (Cap Haitien, Haiti. Specimens in the Frankfort Museum.)

Material examined. From the Museum of Comparative Zoölogy; 1 clitellate specimen labelled, "Grande Anse, Hayti. R. R. Uhler. #2068"; 1 clitellate specimen labelled "Soledad, near Cienfuegos, Cuba. 4–14 Feb. 1912. T. Barbour. #2066"; and 1 clitellate specimen labelled "Havana, Cuba. T. Barbour. #2065". From the United States National Museum: 22 clitellate specimens labelled, "Canefield at Arroyo, P. R. U. S. Fish Com. P. R. Exped. Fishhawk, 1898–99"; 1 clitellate specimen labelled, "Cona, Cuba. #1317. T. L. Hankinson"; 7 clitellate and 1 aclitellate specimens labelled, "133/167. Gatun, C. Z. From greens, golf course. H. M. Thomas".

Diagnosis. Athecal or polythecal, spermathecal pores (when present) minute and superficial, in paired groups, in 5/6—6/7. Male pores minute and invaginate, on oval discs on median wall of eversible parietal invaginations with crescentic apertures. Genital markings transversely oval, presetal, widely paired, on xix–xxiv. Setae *a* enlarged and widely separated midventrally, setae *b* also enlarged on v–xiii; xviii/7–16, 60–75/xx. First dorsal pore in 12/13. Length, 85–355 mm. Diameter, 3½–6 mm. Segments, 169–241.

Acaecal. Testis sacs of x and xi unpaired, U-shaped to annular, seminal vesicles of xi included within the posterior testis sac. Spermathecal duct slender, shorter than the ampulla; diverticular stalk slender, seminal chamber ovoidal to ellipsoidal. Genital marking glands sessile on the parietes.

Variations. The genital markings vary from 3 to 6 pairs. A marking of one or more pairs may be lacking. The hearts of xiii may or may not be present. More interesting however is the variation in the number of spermathecae. Gates (1932, p. 392) found only 51 thecal specimens of this species during ten years collecting in the province of

Burma, the thecal specimens constituting probably less than a fifth of the total number collected. Beddard and Fedarb (1899, p. 803) found only six thecal worms in a batch of 18 specimens from British Guiana. Two of the Puerto Rico worms just examined are thecal. One has a pair of spermathecal pores in 5/6 on the right side, about one intersetal interval apart. The other specimen has a single pore in 5/6 on the right side, and a pair of pores in 6/7 on the right side, the pores two intersetal intervals apart. In a batch of 11 specimens from the Philippines that has just been examined four worms are thecal. One worm has four spermathecal pores, all on the right side, closely paired in 5/6 and 6/7. Another worm has only one pair of pores, in 5/6 also on the right side. A third specimen has 12 spermathecal pores, 7 in 5/6 of which four are closely grouped on the right side, the other three on the left side, while in 6/7 there are 2 pores on the right side and 3 on the left side. The fourth specimen has three pores, all in 5/6, on the right side. Beddard and Fedarb (1899, p. 803) found the spermathecal pores in groups of 2 to 4 and Gates has found the pores in groups of 2 to 3 in Burmese specimens. The spermathecal pores when not grouped, are almost always asymmetrical, a normal and simple pairing of the spermathecae has been noted definitely only once (Gates 1932, p. 393).

A grouped arrangement of the spermathecae characterizes a subgenus of *Pheretima* recently erected by Michaelsen (1934, p. 15). The subgenus *Polypheretima* is further distinguished only by the absence of intestinal caeca. *P. elongata* which is acaecal and when thecal often with a polythecal arrangement of the spermathecae, may possibly have originated in Michaelsen's *Polypheretima* region, an area including the southern portion of the Malay Peninsula, Borneo, Celebes and New Guinea. Actually, *P. elongata* appears to be close to two of Michaelsen's polythecal species, *P. stelleri* (Michaelsen) 1891 and *P. beranensis* Michaelsen 1928. Neither of these two species can be considered, at present, as very clearly distinguished from *P. elongata*.

Distribution. Puerto Rico, Hayti, Cuba and Panama. In South America, Peru, Venezuela, British and Dutch Guiana. Elsewhere, Madagascar, Hawaiian Islands, India, Ceylon, Burma, Siam, New Caledonia, Philippines, Sumatra, Java and Celebes.

Pheretima hawayana

Perichaeta hawayana Rosa 1891, Ann. Hofmus. Wien, **6**, p. 396. (Type locality, "Insel Haway". Types in Vienna Museum.)

Perichaeta hawayana Beddard 1895, Monog. p. 420.
Amyntas hawayanus Beddard 1900 (part), Proc. Zoöl. Soc. London, 1900, p. 645. (Excluding all quadrithecal forms.)
Pheretima hawayana Michaelsen 1900 (part), Das Tierreich, **10**, p. 271. (Excluding all quadrithecal forms.)
Pheretima hawayana Michaelsen 1903 (part), Geog. Verbr. p. 96. (Excluding distribution of all quadrithecal forms.)
Pheretima hawayana Cognetti 1905, Mem. Ac. Sci. Torino, **55**, p. 33.
Pheretima hawayana Smith 1915, Bull. Ill. Sta. Lab. Nat. Hist. **10**, p. 555. (Illinois.)
Pheretima hawayana Smith 1928, Bull. Ill. Nat. Hist. Survey, **17**, p. 359. (Illinois.)
Perichaeta aspergillum Beddard 1890, Quart. J. Mic. Sci. **30**, p. 459. (Bermudas.)
Perichaeta aspergillum Beddard 1891, Proc. R. Phys. Soc. Edinburgh, **10**, p. 269. (Bermudas.)
Perichaeta bermudensis Beddard 1892, Proc. Zoöl. Soc. London, 1892, p. 160. (Type locality, "Bermudas". Types in British Museum.)
Perichaeta bermudensis Beddard 1895, Monog. p. 410.
Perichaeta bermudensis Harper 1905, Biol. Bull. **10**, p. 18. (Greenhouses, Chicago.)
Perichaeta bermudensis Harper 1909, J. Comp. Neur. **19**, p. 569. (Greenhouses.)
Perichaeta barbadensis Beddard 1892 (part), Proc. Zoöl. Soc. London, 1892, p. 167. (Type locality, "Barbados". Types in British Museum?) Excluding cotypes "a" and "c".
Pheretima barbadensis Michaelsen 1900 (part), Das Tierreich, **10**, p. 254. (Excluding quadrithecal forms.)

Material examined. From the Museum of Comparative Zoölogy: 16 clitellate specimens labelled, "Drained cypress swamp containing a high percentage of muck with a subsoil of clay. New Orleans. Percy Viosca Jr. #2074". From the United States National Museum: 2 clitellate specimens labelled, "Baton Rouge, La. I. W. Bradley. Agric. Exp. Sta. #1186". From the British Museum: 4 clitellate specimens labelled, "*Pheretima aspergillum.* 1904.10.5.8.10. Bermudas. coll. Beddard"; and one specimen from a tube labelled, "*Pheretima peregrina.* 1904.10.5.1392–3. West Indies. coll. Beddard".

One of the specimens of "*P. aspergillum*" has an unusually large number of post-clitellar genital markings. There are ten of these markings, all on xviii, and all postsetal. On the right side there is a transverse row of four markings just behind the setae and just median to the male porophore. Behind this row there is a single marking in line with the space between the second and third markings of the row

in front. On the left side there is a transverse row of three markings, also just behind the setae and just median to the male porophore. Behind this row there are two markings in line with the two median markings of the row in front. This worm likewise has preclitellar genital markings, two pairs, postsetal, on vii and viii. The specimen is presumably one of the types of *P. bermudensis*. At least it is one of a batch of 30 to 40 specimens from which the type or types of *bermudensis* were selected.

For a consideration of the types of *P. barbadensis* see *P. morrisi* on a later page.

Diagnosis. Sexthecal, spermathecal pores minute and superficial, 3 pairs, in 5/6–7/8. Male pores minute and superficial, on small, disc-shaped porophores. Genital markings small, paired, postsetal, on vii–viii, or in paired, postsetal clusters on xviii. Setae: vi/4–8, vii/10–15, xvii/16–20, xviii/10–16, xix/16–21, 4–18/xvi, 50–56/xx. First dorsal pore in 10/11. Length, 60–120 mm. Diameter, 3–4 mm. Segments, 71–91.

Intestinal caeca simple. Testis sacs of x and xi unpaired and ventral. Spermathecal duct slender, about as long as the ampulla; diverticulum elongately tubular, seminal chamber not sharply demarcated externally from the stalk. Genital marking glands stalked and coelomic.

Distribution. Mississippi, Illinois, Bermudas and Barbados. In South America, Brazil, Uruguay and Chile. Elsewhere, Hawaiian Islands, Samoa, Fiji, India, Ceylon, Burma, Malay Peninsula, Hongkong, provinces of Chekiang, Szechuan and Yunnan in China, Borneo and Java.

Pheretima hupeiensis

Perichaeta hupeiensis Michaelsen 1895, Abh. Nat. Ver. Hamburg, **13**, p. 35. (Type locality, Shi-hui-yao near Wuchang, Hupeh Province, China. Type in Hamburg Museum.)

Amyntas hupeiensis Beddard 1900, Proc. Zoöl. Soc. London, 1900, p. 646.

Pheretima hupeiensis Michaelsen 1900, Das Tierreich, **10**, p. 273.

Pheretima hupeiensis Chen 1933, Cont. Biol. Lab. Sci. Soc. China, **9**, p. 251. (Campus of University of Pennsylvania, Philadelphia. Specimen in Chen's collection.)

Material examined. From the Hamburg Museum: one clitellate specimen labelled, "V. 9086. *Pheretima hupeiensis* Mich. Cohn. Futschau". From the United States National Museum: one specimen labelled, "51490. Washington, D. C. A. C. Weed", and one speci-

men labelled, "56759. Washington, D. C. F. V. Colville". An account of the Hamburg specimen is at present in press. The two Washington specimens had been sectioned in part. Mr. Y. Chen kindly permitted his specimen to be examined.

The Washington specimens are probably to be referred to *P. hupeiensis*. One is about 70 mm. long and 3 mm. in diameter. Septa 8/9 and 9/10 are present and muscular. The testis sacs are unpaired and U-shaped and the posterior sac contains the anterior seminal vesicles. According to a manuscript note by Prof. Frank Smith, these worms had been identified by Miss Green as "*Pheretima posthuma?*".

Diagnosis. Sexthecal, spermathecal pores minute and superficial, three pairs, on the anterior margins of vii–ix, each pore on a small, protuberant knob. Male pores minute and superficial, at the centres of small, nearly circular, disc-shaped porophores. Genital markings 2 pairs, on 17/18 and 18/19, each marking 3–5 intersetal intervals wide, the markings slightly median to the male porophores. Setae small and closely crowded, present ventrally on the clitellar segments; vii/15, viii/19, xviii/18, 95/x, 81/xiii, 85/xx. First dorsal pore in 11/12–12/13. Length, 45–55 mm. Diameter, 3½–4 mm. Segments, 119–132.

Septa 8/9–9/10 present and muscular. Intestinal caeca simple. Testis sacs of x and xi unpaired and U-shaped, the hearts of x included in the anterior sac, hearts and seminal vesicles of xi included in the posterior sac. Spermathecal duct shorter than the ampulla; diverticulum longer than combined lengths of duct and ampulla, stalk shorter than the elongately tubular seminal chamber. Genital marking glands sessile on the parietes.

Distribution. Philadelphia to Washington. Until Chen found his specimen in Philadelphia this species was known only from China and Central Japan. In China it has been found in Hupei, Szechuan, Kiangsu, Chekiang, Anhwei and Kiangsi provinces. Possibly China is its original home.

Remarks. Chen would appear to have had much larger specimens than those studied by Michaelsen or found in America. According to Chen the species may attain a length of 222 mm. and a diameter of 6 mm.

After completion of the manuscript a tube was received from Dr. W. R. Walton, of the U. S. Department of Agriculture, containing several short, autotomized, tail ends and three clitellate specimens of *P. hupeiensis*. This material had been collected from a putting green

at the Rolling Road Links near Catonsville, Md., about nine miles southwest of Baltimore. Dr. Walton supplied the following notes relative to this worm and its activities.—The Links were visited on the morning of July 11th, 1935. The green was covered with casts that had been made during the previous night. As many as twenty were counted on a single square foot of turf. Two square feet of turf were removed revealing at least twenty specimens of the worm. These lay within an inch of the surface although the maximum air temperatures had been above 90 degrees for several days. The green had previously been treated both with the ordinary solution of four ounces of mercuric bichloride to fifty gallons of water, and four pounds of arsenate of lead to a thousand square feet of surface, without apparent lethal effect on the worms. The worm has a rather strong odour somewhat resembling that of carrots when freshly dug.

The autotomy of the posterior ends was due, presumably, to the irritation produced by the vermicides, though it should be noted that the autotomized fragments were still living when found.

Pheretima meridiana

Pheretima campanulata var. *meridiana* Gates 1932, Rec. Indian Mus. **34**, p. 457. (Type locality, Tavoy District, Burma. Types in authors collection.)

Perichaeta houlleti Beddard 1887, Proc. Zoöl. Soc. London, 1887, p. 389. (Bahamas. Specimens in the British Museum.)

Perichaeta houlleti Beddard 1890, Quart. J. Mic. Sci. **30**, p. 459.

Perichaeta houlleti Beddard 1895 (part), Monog. p. 424. (Including only Bahama forms.)

Amyntas houlleti Beddard 1900 (part), Proc. Zoöl. Soc. London, 1900, p. 613. (Including only Bahama forms.)

Pheretima houlleti Michaelsen 1900 (part), Das Tierreich, **10**, p. 273. (Including Bahama forms only.)

Pheretima houlleti Michaelsen 1903 (part), Geogr. Verbr. p. 97. (Including Bahama forms only.)

Pheretima houlleti Cognetti 1905, Mem. Ac. Sci. Torino, **55**, p. 34.

Material examined. From the British Museum: five softened specimens labelled, "*Pheretima houlleti.* 1904.10.5.51–56. Bahamas. coll. Beddard". One of the specimens had been dissected open, presumably by Beddard.

Length, 140 to 160 mm. Diameter, three to five mm.

The setae begin on ii on which segment there is a complete circle. Complete circles of setae are present on all three clitellar segments.

Formulae: xvii/16, xviii/12, xix/17; vii/17, viii/24, xvii/16, xviii/10, xix/17; vii/15, viii/26, xvii/17, xviii/13, xix/19; vii/17, viii/23, xvii/17, xviii/10, xix/17.

The clitellum is annular and extends from 13/14 to 16/17; dorsal pores and intersegmental furrows lacking.

There are pore-like markings in 7/8–10/11 (1) or 9/10–10/11 (4) which may or may not represent functional dorsal pores.

There are no external genital markings.

Septa 8/9 and 9/10 are lacking.

The intestine begins in xv (4). The intestinal caeca are simple, extending through three or four segments, slightly constricted by the septa through which they pass.

The single heart of ix is on the right side (2), or on the left side (2). The last pair of hearts is in xiii (4). All hearts of ix to xiii pass into the ventral blood vessel.

The testis sacs of x and xi are ventral and either closely paired or unpaired, possibly the latter. Each seminal vesicle is provided with a small primary ampulla, the base of which is slightly sunk into the dorsal margin of the ventral lamina. The prostates extend through xvi to xxi. On the anterior face of each copulatory chamber are three glands the stalks of which pass into the roof of the chamber median to the prostatic duct. There are no glands on the posterior faces of the copulatory chambers and no penial setae in the chambers. Within the copulatory chamber, on the median wall there is a single, small, circular, greyish-translucent genital marking. The penial body is rather conical, with a slightly bilobed appearance due to the presence at the extreme tip, of a genital marking in addition to the papilla that bears the male pore. Both copulatory chambers of one specimen are fully everted as conspicuously protuberant porophores, almost columnar in shape, but tapering very slightly at the ventral end. Each porophore is about 2 mm. high, the anteroposterior diameter slightly greater than the lateromesial diameter. The surface is smooth but not glistening. At the ventral tip is the male porophore. On the median face and about half the distance up from the tip is the genital marking which is not protuberant.

The duct of a stalked, coelomic gland passes into the anterior face of each spermathecal invagination just at the parietes. The stalk of a similar, coelomic gland passes into the posterior face of each spermathecal invagination. The diverticulum passes into the bulbous portion of the spermathecal duct ental to the parietes and comprises a short, bent, muscular stalk and an elongately tubular seminal chamber.

The latter widens slightly but gradually passing entally and is bent into a more or less regularly zigzagged series of loops, the limbs of the loops bound closely together.

In the previously dissected specimen, the posterior stalked gland to the left spermathecal invagination of ix, and the anterior and posterior glands to the right spermathecal invagination of ix were not found. These glands may have been removed by Beddard.

The Bahama worms differ from *P. houlleti* as follows: slightly larger size, slightly larger number of male setae on xviii, presence of a gland with stalk passing into the posterior wall of each spermathecal invagination, absence of a gland on the posterior face of the copulatory chamber, the shape of the penial body, and possibly also by a more posterior location of the first dorsal pore. The Bahama worms are nearest to Burmese forms hitherto referred to variety *meridiana* of *P. campanulata* (Rosa) 1890, and differ from the Burmese forms only very slightly, *i.e.*, with regard to the number of spermathecal setae on viii and possibly the location of the first dorsal pore.

Diagnosis. Sexthecal, spermathecal pores minute and invaginate; each pore on a tiny conical protrusion into the lumen of a transversely slit-like invagination; apertures of the invaginations transversely slit-like, three pairs, on 6/7–8/9. Male pores minute and invaginate, each pore on a penial body protuberant into the lumen of an eversible copulatory chamber, penial body with a bilobed tip, one of the lobes bearing a genital marking. Genital markings tiny, circular, greyish, translucent areas sharply demarcated by slight circumferential furrows, internal only. Two markings within each spermathecal invagination, one on the anterior wall and one on the posterior wall; two markings within each copulatory chamber, one of which is always on a lateral lobe of the penial body. Setal circles present on all clitellar segments, clitellar setae with bifid tips; vii/11–17, viii/15–26, xvii/15–21, xviii/10–16, xix/15–20, 20–26/iii, 30–40/viii, 44–54/xii, 48–60/xx. First dorsal pore in 11/12. Length, 110–200 mm. Diameter, 3–8 mm. Segments, 119–131.

Intestinal caeca simple. Testis sacs of x and xi unpaired and ventral. Two or more stalked glands on the anterior face of each copulatory chamber. Spermathecal duct bulbous, shorter than the ampulla; diverticulum into duct entally, comprising a slender stalk and a slightly longer, elongately tubular, seminal chamber, the latter widened slightly at the ental end and looped, often in a regular zigzag or an approximation thereto. Genital marking glands stalked and coelomic.

Distribution. Bahama Islands. Outside of North America known only from the province of Burma where it has been found in Mergui, Tavoy, Amherst, Thaton, and Toungoo Districts and the Shan States.

Remarks. P. meridiana is distinguished from *P. campanulata* by the absence of external genital markings, the absence of stalked glands on the posterior faces of the copulatory chambers, the absence of penial setae, the shape of the penial body, the presence of only one genital marking on the penial body, and the presence of only one further genital marking within the copulatory chamber. The seminal vesicles of *meridiana* are smaller than in *campanulata* and are more like those of *P. houllcti.*

Pheretima morrisi

Perichaeta morrisi Beddard 1892, Proc. Zoöl. Soc. London, 1892, p. 166. (Type locality, Penang? Types, in the British Museum?)

Perichaeta morrisi Beddard 1895, Monog. p. 411.

Pheretima morrisi Michaelsen 1900, Das Tierreich, **10**, p. 287.

Perichaeta barbadensis Beddard 1892 (part), Proc. Zoöl. Soc. London, 1892, p. 167. (Type locality, Barbados. Cotypes "a" and "c" only. For cotype "b" see *P. hawayana.*)

Perichaeta barbadensis Beddard 1895, (part), Monog., p. 412. (Excluding sexthecal form.)

Pheretima barbadensis Michaelsen 1900 (part), Das Tierreich, **10**, p. 254. (Excluding all sexthecal forms.)

Amyntas hawayanus Beddard 1900 (part), Proc. Zoöl. Soc. London, 1900, p. 645. (Excluding all sexthecal forms.)

Pheretima hawayana Michaelsen 1903 (part), Geog. Verbr., p. 96. (Excluding distribution of sexthecal forms.)

Pheretima hawayana Cognetti 1905 (part), Mem. Ac. Sci. Torino, **55**, p. 33. (Excluding sexthecal forms.)

Material examined. From the United States National Museum: 4 clitellate specimens labelled, "Waxahachi, Texas. Mr. Powers. May 1916. #1097." From the British Museum: 3 specimens labelled, "*Pheretima barbadensis* 1904.10.5.11–12. Barbados. coll. Beddard" and 1 aclitellate and 1 partially clitellate specimen labelled, "*Pheretima morrisi.* 1904.10.5.106–116. Hongkong. coll. Beddard."

One of the Texas specimens has an unusually large number of post-clitellar genital markings; a transverse presetal row of six markings on xviii and a transverse presetal row of six markings on xix, in addition to the usual presetal and postsetal markings immediately median to the male porophores.

The British Museum specimens from Hongkong are, according to

Dr. C. C. A. Monro, the types of *P. morrisi*. There is obviously a mistake somewhere as Beddard says that the types of the species were received from Penang via the Kew Gardens. On the supposed types of *P. morrisi* the genital markings are as follows: aclitellate specimen, three markings presetal and lateral on vii, two on the right and one on the left side, two markings in the usual positions just median to each male porophore; partially clitellate specimen, one median, unpaired, presetal marking each on vi, vii and viii, paired lateral presetals each on vii, xviii and xix, two markings just median to each male porophore on xviii. Beddard says that there "are no papillae in the neighborhood of the male pores" (1892, p. 166) but notes further that on dissection some white glands were found in xviii. The presence of these glands may be taken to indicate that external genital markings had been overlooked by Beddard. In this connection it may be pointed out that in recent re-examination of types of certain of Beddard's, Ude's and Michaelsen's species, genital markings have been found either on specimens on which these markings were said to be lacking or else on locations on which genital markings had not been previously observed. With maceration and loss of cuticle consequent on the original dissection such markings are, apparently, much more readily visible than previously. Prior to the removal of the cuticle external characteristics can sometimes be determined only with difficulty, especially if corrosive sublimate has been used in the processes of killing and fixing.

The three specimens of *P. barbadensis* are probably the types of this species although here again the genital markings are not exactly as described. One specimen has genital markings as follows; on vii, an unpaired, presetal median and a pair of presetal laterals; on viii, an unpaired presetal median; on xviii, the usual pair just median to each male porophore, one pair of presetal laterals and just to the right of the midventral line a group of three presetal markings as described and figured by Beddard; on xix, a pair of presetal laterals. This is doubtless the cotype which Beddard referred to as "c." On the second specimen the genital markings are as follows: on vii, an unpaired presetal median; on xviii, the usual pairs just median to the male porophores and an unpaired, median presetal. This specimen is probably the cotype which Beddard called "a." A third specimen, possibly cotype "b," is incomplete, the anterior portion having been removed at a level just behind the prostatic segments. This specimen, according to the description given by Beddard is to be referred to *P. hawayana*. Even if these three specimens are not the cotypes of *P. barbadensis* this species can be definitely relegated to the synonymy of *P. morrisi*

and *P. hawayana* on the basis of the characteristics mentioned by Beddard.

Diagnosis. Quadrithecal, spermathecal pores minute and superficial, two pairs, in 5/6–6/7. Male pores minute and superficial, on small, circular to transversely oval, disc-shaped porophores. Genital markings small, circular to transversely oval and disc-shaped, widely paired or unpaired and median, presetal on v-viii; one pair just median to each male porophore, with one marking presetal and the other postsetal; postsetal on xvii and xviii, presetal on xviii and xix. Setae: vi/21–28, xvii/17–23, xviii/10–17, xix/18–23, 46–49/xx. First dorsal pore in 10/11. Length, 40–150 mm. Diameter, 2½–6 mm. Segments, 87–95.

Intestinal caeca simple. Testis sacs of x and xi paired and ventral. Spermathecal duct elongate and slender, diverticulum elongately tubular without definite external demarcation into stalk and seminal chamber. Genital marking glands stalked and coelomic.

Distribution. Mississippi,[1] Texas and Barbados. In South America, Brazil and Chile. Elsewhere, Hawaiian Islands, Cape Verde, Penang, India, Burma, Sumatra, Hongkong and the provinces of Szechuan, Yunnan, Fukien and Chekiang in China. *P. morrisi* is probably more widely spread than is indicated above but the species has been confused until recently with *P. hawayana.*

Pheretima posthuma

Perichaeta posthuma L. Vaillant 1868, Ann. Sci. Nat., Ser. 5, **10**, p. 228. (Type locality, Java. Types in Paris Museum.)
Perichaeta posthuma Beddard 1895, Monog., p. 424.
Megascolex posthuma Vaillant 1889, Hist. Nat. Annel., **3**, part 1, p. 72.
Amyntas posthumus Beddard 1900, Proc. Zoöl. Soc. London, 1900, p. 641.
Pheretima posthuma Michaelsen 1900, Das Tierreich, **10**, p. 295.
Pheretima posthuma Michaelsen 1903, Geog. Verbr., p. 99.
Pheretima posthuma Cognetti 1905, Mem. Ac. Sci. Torino, **55**, p. 34.
Perichaeta affinis Beddard 1887, Proc. Zoöl. Soc. London, 1887, p. 389. (Bahamas. The specimens are not in the British Museum and probably have not been preserved.)

Diagnosis. Octothecal, spermathecal pores minute and superficial, four pairs, on the posterior margins of v–viii, each pore on a transversely oval, glistening area. Male pores minute and invaginate, on

[1] The occurrence in Mississippi is based on a note in a manuscript deposited with the United States National Museum by Prof. Frank Smith. The specimens, from New Orleans, were dentified by Miss Green.

tiny, circular, disc-shaped porophores within small, parietal invaginations eversible as columnar porophores. Genital markings in the setal circles of xvii and xix, just median to the male pore lines, 2 pairs. Setae present ventrally on some or all of the clitellar segments; vi/36–40, vii/38–43, viii/38–43, xvii/16–20, xviii/17–22, xix/16–20, 95/xx. First dorsal pore in 12/13. Length, 60–140 mm. Diameter, 3–7 mm. Segments, 140.

Septum 8/9 present and muscular. Hearts of x and xi replaced by small commissural loops connecting the ventrolaterals and the supraoesophageals. Testis sacs unpaired; of x ventral, of xi U-shaped and enclosing the anterior seminal vesicles.

Spermathecal duct shorter than the ampulla; diverticular stalk very short and slender, seminal chamber ovoidal and longer than the stalk. Genital marking glands sessile, interrupting the musculature and slightly protuberant into the coelom.

Variations. One or more of the genital markings may be lacking. One or more extra genital markings may be present on segments xvi, xx–xxviii.

Distribution. Bahamas. Unknown from South America. Elsewhere, from New Hebrides, Amboina, Sumba, Flores, Sumatra, Java, Malay Peninsula, Burma, India, Siam, Cochin-China, Celebes and the Philippines.

Pheretima robusta

Perichaeta robusta E. Perrier 1872, N. Arch. Mus. Paris, **8**, p. 112. (No type locality designated. Three types from Île de France, and one from Manila? Types in Paris Museum.)
Perichaeta robusta Beddard 1895, Monog., p. 430.
Megascolex robustus Vaillant 1889, Hist. Nat. Annel., **3**, part 1, p. 76.
Amyntas robustus Beddard 1900, Proc. Zoöl. Soc. London, 1900, p. 648.
Pheretima robusta Michaelsen 1900, Das Tierreich, **10**, p. 299.
Pheretima robusta Gates 1934, Rec. Indian Mus., **36**, p. 264. (West Indies.)

Material examined. From the British Museum: 1 specimen labelled "*Pheretima mandhorensis*. 1904.10.5.1401. West Indies. coll. Beddard". A number of specimens from the United States National Museum and from the Hamburg Museum have been examined. A report on these worms is at present in press.

Diagnosis. Quadrithecal, spermathecal pores minute and superficial, 2 pairs, in 7/8–8/9. Male pores minute and superficial, on small, circular to transversely oval, disc-shaped porophores. Genital markings small, circular to transversely oval and disc-shaped, on vii,

viii and ix and xviii. Setae: viii/17–26, xvii/24–28, xviii/16–21, xix/23–27, 65–70/xx. First dorsal pore in 11/12. Length, 150–180 mm. Diameter, 6–7 mm.

Intestinal caeca simple. Testis sacs of x and xi unpaired and ventral. Spermathecal diverticulum with long stalk, the ental portion of which is shortly looped, seminal chamber ellipsoidal. Genital marking glands stalked and coelomic.

Variation. There is probably considerable variation as to number and location of the genital markings but hitherto only a few specimens have been carefully studied.

Distribution. West Indies. Unknown from South America. Elsewhere, Mauritius, Madagascar and China. The species is probably widely distributed in China but is known with certainty only from Fukien and Szechuan provinces and from Hongkong. *P. lauta* Chen 1933 from Chekiang, Kiangsu and Kiangsi provinces is at least in part referable to *P. robusta*. The species may possibly extend into northern Burma (*P. ornata* Gates 1929) and northern India (*P. himalayana* Stephenson 1925). With a wide Chinese distribution it is possible that the original home of the species may be in China.

Pheretima rodericensis

Perichaeta rodericensis Grube 1879, Phil. Trans. London, **168**, p. 554. (Type locality, Rodriguez. Type in Hamburg Museum, paratypes in British Museum.

Megascolex rodericensis Vaillant 1889, Hist. Nat. Annel., **3**, part 1, p. 85.

Pheretima rodericensis Michaelsen 1900, Das Tierreich, **10**, p. 299. (Definition after re-examination of type.)

Pheretima rodericensis Michaelsen 1902, Mitt. Mus. Hamburg, **19**, p. 9. (Arecibo, Puerto Rico. Specimens in Hamburg Museum.)

Pheretima rodericensis Moore 1902, Proc. Philadelphia Ac. Sci., **54**, p. 83. (Bermudas.)

Pheretima rodericensis Michaelsen 1903, (part), Geog. Verbr., p. 99. (Excluding distribution of *P. shimaensis*.)

Pheretima rodericensis Cognetti 1905, Mem. Ac. Sci. Torino, **55**, p. 34.

Pherctima rodericensis Michaelsen 1908, Zoöl. Jahrb., Sup. **11**, p. 14. (Trinidad. Specimens in Hamburg Museum.)

Pheretima rodericensis Michaelsen 1922, Cap. Zoöl., **1**, part 3, p. 37. (Martinique, Specimens in Rijks Museum, Leyden.)

Perichaeta dyeri Beddard 1892, Proc. Zoöl. Soc. London, 1892, p. 157. (Type locality unknown, types received from Kew Gardens to which they had been imported. Jamaica and Trinidad.)

Perichaeta dyeri Beddard 1895, Monog., p. 411.

Amyntas dyeri Beddard 1900 (part), Proc. Zoöl. Soc. London, 1900, p. 633. (Excluding *P. shimaensis*.)

Amyntas dyeri Michaelsen 1900, Zoöl. Anz., **23**, p. 53. (St. Pierre, Martinique. Specimens in Munich Museum.)

Perichaeta trinitatis Beddard 1896, Proc. Zoöl. Soc. London, 1896, p. 206. (Type locality, Trinidad. Type in British Museum?)

Amyntas trinitatis Beddard 1900, Proc. Zoöl. Soc. London, 1900, p. 624.

Pheretima trinitatis Michaelsen 1900, Das Tierreich, **10**, p. 318.

Perichaeta sinensis Beddard 1896, Proc. Zoöl. Soc. London, 1896, p. 208. (Trinidad and Grenada. Specimens in British Museum.)

Material examined. From the Museum of Comparative Zoölogy: 1 clitellate specimen labelled, "St. Kitts, April 11, '79. F. L. Lagois. Garman. #2069", 2 clitellate specimens labelled, "Martinique, Morne Rouge, Feb. 3, 1879. Garman", and 4 clitellate specimens labelled, "Jamaica, A. G. Wright coll. #2071". From the American Museum of Natural History: 1 clitellate specimen lacking the anteriormost six segments, labelled, "Yauco, P. R. Jan. 15, 1915. Caves about 11 kilometres from town. Prof. H. E. Crampton. #4500". From the United States National Museum: 1 clitellate specimen labelled, "Hamilton, Bermuda. April 20, 1903. E. L. Mark. #1321". From the British Museum: four specimens in an advanced stage of maceration labelled, "*Perichæta rodriguezensis* Grube type. Is. of Rodriguez (Gulliver) Pres. by the Royal Society 76.5.5.11". *Pheretima rodericensis* has been added by another hand on a second label. These worms are presumably paratypes of *P. rodericensis*. Michaelsen states (*in litt.*) that Grube actually studied only one specimen and that this worm is in the Hamburg Museum. A number of worms from a jar labelled, "*Pheretima rodericensis*. 1904.10.5.152–160. Jamaica. coll. Beddard". The label originally bore the name *sinensis* but this has been crossed out and replaced by *rodericensis*. Five specimens labelled, "*Pheretima rodericensis* 1904.10.5.30–33. Jamaica. coll. Beddard". The label originally bore the name *dyeri* but this has been crossed out. Thirteen clitellate specimens labelled, "*Pheretima rodericensis* 1904.10.5.1257–62. Trinidad. coll. Beddard". Inside the jar is a label with "Trinidad. *P. dyeri*" thereon. Twenty one clitellate and 6 aclitellate specimens labelled, "*Pheretima rodericensis* 1904.10.5.1240–45. Trinidad. coll. Beddard". Inside the jar is a label with "Trinidad. *P. dyeri*" thereon. Three clitellate and 1 aclitellate specimens labelled, "*Pheretima rodericensis*. 1904.10.5.27–29. Trinidad. coll. Beddard". The label originally bore the name "*dyeri*" but this has been crossed out. One clitellate specimen without genital markings labelled, "*Pheretima trini-*

tatis 1904.10.5.170. Trinidad. coll. Beddard". This specimen may possibly be the type of *trinitatis*.

On most of the specimens intersegmental furrows 17/18 and 18/19 are not distinct or recognizable ventrally. It has not therefore been possible to determine definitely the position of the genital markings. These markings appear however to belong largely to segment xviii though in some specimens there is an appearance as if encroaching on xvii and (or) xix. The anterior genital markings are often lacking. In one jar eight clitellate specimens have two pairs of genital markings. One clitellate specimen has the posterior markings and one anterior marking. Thirteen clitellate and five aclitellate specimens have the posterior genital markings only.

Septa 8/9–9/10 are lacking. Hearts are present in x to xiii, the right heart of ix lacking. All hearts of ix to xiii pass into the ventral vessel. The intestinal caeca are simple, extending through three or four segments, occasionally deeply constricted by the septa through which they pass.

The testis sacs of x and xi are unpaired and ventral but the anterior margin of each sac may be deeply bilobed. The prostates extend through xvi or xvii to xxi or xxii.

The spermathecal duct is shorter than the ampulla and is narrowed within the parietes. The stalk of the diverticulum is variable in length relative to the seminal chamber but is always longer than the duct. The seminal chamber is elongate, ellipsoidal or moniliform.

The genital marking glands are shortly stalked and coelomic, aggregated, *i.e.*, a number of glands are connected by their own individual stalks with a single external genital marking. As many as 35 glands have been noted passing to one genital marking.

Diagnosis. Octothecal, spermathecal pores minute and superficial, dorsal, 4 pairs, in 5/6–8/9. Male pores minute and superficial, on circular to transversely oval, disc-shaped porophores. Genital markings transversely oval, one pair just median to each male porophore. Setae enlarged on some of the preclitellar segments; vi/7+20, vii/7+22, viii/8+27, xvii/20, xviii/18–20, xix/21, 33/v, 24/vii, 40/xi, 42/x, 44/xx. First dorsal pore in 11/12. Length, 84–150 mm. Diameter, 4–6 mm.

Intestinal caeca simple. Testis sacs of x and xi unpaired and ventral. Spermathecal duct shorter than the ampulla, diverticular stalk longer than the duct, seminal chamber elongately sausage-shaped or moniliform. Genital marking glands shortly stalked and coelomic, aggregated.

Variations. One or more or even all of the genital markings may be lacking.

Distribution. Puerto Rico, Jamaica, Bermudas, St. Kitts, Martinique, Trinidad and Grenada. In South America, Dutch Guiana and Venezuela. Elsewhere, has been found in greenhouses in England, Russia, Bohemia, Switzerland and Poland, in Botanical Gardens in Italy and Germany. Known from Madagascar, Mauritius, Moheli, Nossi Bè, and Lagos. There is one record of the species from six localities in New Caledonia (90 specimens) and one doubtful record from Foochow, China. *P. rodericensis* is therefore almost unknown in the "*Pheretima* domain."

Pheretima schmardae

Megascolex schmardae Horst 1883, Notes Leyden Mus., **5**, p. 194. (Type locality, Japan. Type in Leyden Museum.)

Megascolex schmardae Vaillant 1889, Hist. Nat. Annel., **3**, part 1, p. 77.

Perichaeta schmardae Beddard 1895, Monog., p. 394.

Amyntas schmardae Beddard 1900 (part), Proc. Zoöl. Soc. London, 1900, p. 619. (Excluding *vesiculata*.)

Pheretima schmardae Michaelsen 1900, Das Tierreich, **10**, p. 302.

Pheretima schmardae Moore 1902, Proc. Philadelphia Ac. Sci., **54**, p. 83. (Walsingham, Bermudas.)

Pheretima schmardae Michaelsen 1903, Geog. Verbr., p. 99.

Pheretima schmardae Cognetti 1905, Mem. Ac. Sci. Torino, **55**, p. 34.

Perichaeta sumatrana Beddard 1892, Proc. Zoöl. Soc. London, 1892, p. 155. ("5 or 6 specimens in Wardian cases received in Kew from Barbados and Hongkong").

Perichaeta sumatrana Beddard 1895 (part), Monog., p. 422.

Perichaeta trityphla Beddard 1896, Proc. Zoöl. Soc. London, 1896, p. 205. (Type locality, Barbados. Type in British Museum?)

Amyntas capensis Beddard 1900 (part), Proc. Zoöl. Soc. London, 1900, p. 618. (Excluding forms with short seminal chambers.)

Pheretima capensis var. *sumatrana* Michaelsen 1900, (part), Das Tierreich, **10**, p. 260. (Excluding forms with short seminal chambers.)

Pheretima capensis Michaelsen 1903 (part), Geog. Verbr., p. 95. (Excluding distribution of forms with short seminal chambers.)

Pheretima capensis Cognetii 1905, Mem. Ac. Sci. Torino, **55**, p. 33.

Material examined. From the British Museum: one specimen labelled, "*Pheretima schmardae* 1904.10.5.169. Barbados. coll. Beddard". The specific name on the jar had originally been *trityphla* but this has been crossed out. The specimen is presumably a type of *trityphla*. A report on the examination of several specimens from the

United States National Museum and from the Hamburg Museum is at present in press.

Diagnosis. Quadrithecal, spermathecal pores minute and superficial, 2 pairs, in 7/8—8/9. Male pores minute and invaginate, each on a small tubercle in a large copulatory chamber with transversely slit-like to circular aperture. No external genital markings. Setae enlarged ventrally on some of the preclitellar segments; viii/26–34, xvii/16–22, xviii/10–20, xix/16–22, 24/v, 49/ix, 47–53/xx. First dorsal pore in 11/12–12/13. Length, 50–90 mm. Diameter, 2–4 mm.

Intestinal caeca compound, glove-shaped, dorsalmost secondary caecum the longest. Hearts of x lacking. Testis sacs of x and xi unpaired and ventral. An ovoidal glandular mass on the coelomic face of the copulatory chamber anteriorly and posteriorly, each gland opening into a thin-walled sac by a minute pore on a circular genital marking, the sac opening by a large aperture into the lumen of the chamber. Spermathecal duct shorter than the ampulla, bulbous, invaginate into the ampulla; diverticular stalk longer than the duct, seminal chamber elongately tubular, straight or looped.

Distribution. Bermudas and Barbados. Not known in South America. Elsewhere, Madagascar, Reunion, Hawaiian Islands, Japan and China. In China *P. schmardae* has been found at Hongkong, Macao, and in Szechuan, Chekiang and Hupei provinces. The original home of this species may possibly be somewhere in China or Japan.

Remarks. The disposition of *Perichaeta sumatrana* Beddard 1892 from the Barbados requires explanation as there has always been some doubt as to its status. ("I am not quite certain whether to identify this species with *Perichaeta sumatrana* or whether to regard it as new." Beddard, 1892, p. 156.) Beddard examined "five or six specimens of this species" which had been found in Wardian cases brought to the Kew Gardens from the Barbados and Hongkong. A possibility that specimens from the two localities had been accidentally transferred is mentioned (1892, p. 156) but rejected because each box contained in addition another and distinct species. In 1896 Michaelsen (p. 234) suggested that *sumatrana* might be either *P. capensis* Horst 1883 or a subspecies of *capensis*. Beddard later (1900, p. 618) accepted Michaelsen's first suggestion and placed his own *sumatrana* in the synonymy of *capensis*, a procedure which was also followed by Cognetti in 1905. Michaelsen, however, has never quite known what to do with the Barbados forms. In 1900 (p. 260), they are referred (with one interrogation mark) to variety *sumatrana* of *capensis*, in 1910 (p. 86) to *P. quadragenaria* (Perrier) 1872, in 1922 (p. 54) to *capensis* (with

two interrogation marks) but without subspecific or varietal status, and in the same paper (p. 59) to *quadragenaria* (also with two interrogation marks).

Beddard's description of the Barbados worms is very brief and was never amplified or corrected. The specimens, unfortunately, have been lost or can no longer be recognized. The British Museum which bought Beddard's collection in 1905 has, according to C. C. A. Monro, no specimens of *sumatrana* at all and none of *capensis* either from the Barbados or Hongkong. In the collection just mentioned there are two specimens of *californica* from the Barbados which are labelled "*Pheretima* species". Any possibility that these might have been from the lot referred to *sumatrana* seems to be ruled out of consideration by the absence of large copulatory chambers. The slight amount of information in Beddard's description that is pertinent to this discussion may be summarized as follows:—

No genital markings. The intestine "has the usual pair of caeca." The spermathecae are in vii and viii. Each spermathecal diverticulum is "bent upon itself three times". There are large copulatory chambers.

The position of the spermathecal pores is unknown but with the location of the spermathecae in vii and viii the pores may have been either in 6/7–7/8 or 7/8–8/9. Since there is no widely peregrine species with spermathecal pores in 6/7–7/8 it seems proper to assume that the pores were actually in 7/8–8/9. The statement with regard to the spermathecal diverticula may be taken to indicate that the diverticulum is looped in a regularly zigzagged fashion or an approximation thereto. Such a looping rules out of further consideration *capensis* and *quadragenaria* both of which, as at present defined by Michaelsen, are quite unknown outside of the proper *Pheretima* domain. (The occurrence of *P. capensis* on the Cape of Good Hope must certainly be regarded as very doubtful.)

With the elimination of *capensis* and *quadragenaria* there only remains for consideration those widely peregrine, quadrithecal species with spermathecal pores in 7/8–8/9. Of these, three which are already known from the West Indies require mention. *P. robusta* can be at once ruled out as it has external genital markings and no copulatory chambers. *P. californica* has simple intestinal caeca and no genital markings but lacks large copulatory chambers. *P. schmardae* has no external genital markings, has large copulatory chambers but the intestinal caeca are compound and glove-shaped. It is, however, quite easy to see how the smaller, more ventral, secondary intestinal

caeca of *schmardae* could have been overlooked either through failure to pin out the body wall far enough away from the intestine or to roll the gut over onto one side or the other. On the assumption that the smaller, secondary intestinal caeca were overlooked, which is quite justifiable in view of the character of Beddard's work, *P. sumatrana* Beddard 1892 can be placed in the synonymy of *schmardae* without qualification or reservation, a procedure which is quite impossible so far as any other species is concerned.

Pheretima taprobanae

Perichaeta taprobanae Beddard 1892, Proc. Zoöl. Soc. London, 1892, p. 163 (Type locality, Ceylon. Types in British Museum.)
Perichaeta taprobanae Beddard 1895, Monog., p. 411.
Amyntas taprobanae Beddard 1900, Proc. Zoöl. Soc. London, 1900, p. 648.
Pheretima taprobanae Michaelsen 1900, Das Tierreich, **10**, p. 308.
Pheretima taprobanae Moreira 1903, Arch. Mus. Rio Janeiro, **12**, p. 132. (Rio de Janeiro.)

Material examined. From the British Museum: two partially clitellate, dissected specimens from a tube labelled, "*Pheretima taprobanae* 1904.10.5.163/4. Colombo. coll. Beddard", one macerated, clitellate specimen labelled, "*Pheretima taprobanae* 1904.10.5.165. coll. Beddard", and two partially clitellate and 14 clitellate specimens labelled, "*Pheretima taprobanae* var. *pauli*. 1904.10.5.1286–96. Ceylon. coll. Beddard". In the last jar is a paper inscribed, "Ceylon—Freeman. *Perichaeta pauli*". The specimens from the first or second or both jars are probably the types of *taprobanae*.

The setae begin on ii on which segment there is a complete circle. The setae are small and closely spaced both dorsally and ventrally, a small but definite gap in the circles midventrally. Formulae: viii/41, xvii/22, xviii/19, xix/23; viii/37, xvii/22, xviii/15, xix/22; viii/36, xvii/25, xviii/18, xix/22; viii/34, xvii/20, xviii/14, xix/19, viii/37, xvii/23, xviii/19, xix/25; viii/34, xvii/23, xviii/17, xix/23. Setal circles are present on all three clitellar segments.

The first dorsal pore is in 12/13 (6).

The male pores are minute and superficial, each pore on a poorly demarcated, circular porophore which extends from just anterior to the setae of xviii to 18/19. The male pores accordingly appear to be slightly postsetal. The single female pore is median and presetal. The spermathecal pores are minute and superficial, one pair, on the anteriormost margin of viii, each pore on a very slight tumescence.

The segmental location of the spermathecal pores is especially obvious on the immature or partially mature specimens.

The genital markings are small, circular, or nearly so, presetal, and in two longitudinal rows, one pair each on (vi), vii, viii, ix, x, (xi), xviii, xix, xx, xxi (and xxii). The preclitellar markings appear to be a trifle smaller than the postclitellar and are about eight to ten intersetal intervals median to the spermathecal pores. The markings on xviii are just median to the male porophores, those on xix in line with the markings of xviii, while those of xx to xxii are usually slightly median to those on xviii and xix. As might be expected, there are variations with respect to the number of markings, from the pattern mentioned above, such as the absence of markings on xviii, xix and xxii, xi and vi, especially the three latter.

Septum 8/9 is complete but thin and transparent; 9/10 lacking.

The intestine begins in xv (5). There are no intestinal caeca (5).

There is a pair of hearts belonging to ix (5); hearts of x are lacking (5); hearts of xi included within the testis sac; hearts of xii free; hearts of xiii lacking. All hearts of ix, xi and xii pass into the ventral blood vessel.

The testis sacs of x and xi are unpaired and annular. The dorsal blood vessel passes into both sacs. The seminal vesicles of xi are included within the posterior testis sac. Each seminal vesicle is small, vertically placed, and rather columnar in shape. The dorsalmost portion of the column may be slightly thickened, softish and irregular or firmer and smooth surfaced. The prostates are small and confined to xviii. The prostatic duct is bent into a U-shaped loop, the ectal limb slightly thicker than the ental. The duct passes into the parietes in the posterior portion of xviii.

The spermathecae are small; the duct slightly shorter than or about as long as the ampulla, abruptly narrowed in the deeper portion of the parietes. The diverticulum which passes into the anterior face of the duct at the parietes is as long as or slightly shorter than the combined lengths of duct and ampulla. The seminal chamber is spheroidal, ovoidal or irregular. No spermatozoal iridescence was noted in the diverticula of any of the specimens. The seminal chamber may be separated from the stalk by a narrower neck that lacks the muscular sheen of the stalk.

The genital markings are merely slight epidermal thickenings; no glandular tissue was to be found in connection with markings either in the parietes or within the coelom.

Diagnosis. Dithecal, spermathecal pores minute and superficial,

one pair, on the anterior margin of viii. Male pores minute and superficial, on indistinctly delimited, circular, postsetal porophores. Genital markings small, presetal, in longitudinal rows, 1 pair each on vi–xi and xviii–xxii. Setae present on all clitellar segments; viii/34–41, xvii/20–25, xviii/14–19, xix/19–25, 70/v, 77/x, 74/xiii. First dorsal pore in 12/13. Length, 80–145 mm. Diameter, 4–6 mm. Segments, 95–122.

Septum 8/9 complete but membranous. Acaecal. Hearts of x and xiii lacking. Testis sacs of x and xi unpaired and annular, seminal vesicles and hearts of xi included within the posterior sac. Spermathecae small; diverticulum with spheroidal to ovoidal seminal chamber and slender, muscular stalk that passes into the anterior face of the duct. Genital markings slight epidermal thickenings without internal glands.

Distribution. The only American record is Rio de Janeiro, Brazil. Elsewhere, known from Ceylon, South India (Trivandrum) and Madagascar. The species is quite unknown within the *Pheretima* region!

BIBLIOGRAPHY

Beddard, F. E.

1892. On some species of the genus *Perichaeta*. Proc. Zoöl. Soc. London, 1892.

1895. A monograph of the order Oligochaeta. Oxford.

1900. A revision of the earthworms of the genus *Amyntas*. Proc. Zoöl. Soc. London, 1900.

Beddard, F. E. and Fedarb, S. M.

1899. Notes upon two earthworms, *Perichaeta biserialis* and *Trichochaeta hesperidum*. Proc. Zoöl. Soc. London, 1899.

Gates, G. E.

1932. The earthworms of Burma. III. Rec. Indian Mus., **34**.

Michaelsen, W.

1896. Oligochaeten. Abh. Senck. Ges. Frankfurt, **23**, Part 2.

1900. Oligochaeta, in Das Tierreich, **10**. Berlin.

1903. Die geographische Verbreitung der Oligochaeten. Berlin.

1910. Die Oligochätenfauna der vorderindisch-ceylonischen Region. Abh. Nat. Ver. Hamburg, **19**, No. 5.

1922. Oligochäten aus dem Rijks Museum van natuurlijke Historie zu Leiden. Cap. Zoöl., **1**, Af. 3.

1934. Oligochaeta from Sarawak. Quart. J. Mic. Sci., **77**.

Stephenson, J.

1930. The Oligochaeta. Oxford.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
Vol. LXXX, No. 9

NOVITATES CUBANAE

By Thomas Barbour and Benjamin Shreve

With Four Plates

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
September, 1937

No. 9.—*Novitates cubanae*

By Thomas Barbour and Benjamin Shreve

INTRODUCTION

The senior author is at this point inclined to be a bit reminiscent. It was, he believes, Doctor C. T. Ramsden who first stoutly protested at the arrangement of the species of Eleutherodactylus which the senior author preferred for use in the Herpetology of Cuba, published in the Memoirs of the Museum of Comparative Zoölogy in 1919, and it is a tribute to his innate courtesy that he finally acquiesced to an arrangement in which he was strongly disinclined to believe. The views which the senior held during the early years of his work on West Indian Amphibia were perhaps unconsciously prejudiced by the work of predecessors and by a sort of innate feeling that there could not, by any probability, be so many members of a single genus on islands of the size of the Greater Antilles. How extraordinarily incorrect his belief was, is shown by the enormous number of forms which have been and are still being discovered. Some, probably not very many, will fall as synonyms, others, probably a great many, will ultimately be recognized as geographic races rather than as "full species" when much more collecting and much more field observing has been done.

Many more hills and mountains remain to be intensively searched, particularly in Cuba and San Domingo; and in Cuba there are large areas of the central portion of the Island between the eastern border of the Province of Santa Clara and the mountains of Oriente, which may be expected to provide the information necessary to indicate the relationship and to produce intergrades between forms now known in the eastern and western parts of the Island. Whether there are hills high enough to shelter forms relating to those found in the higher parts of the mountains of Santa Clara and of Oriente may perhaps be doubtful, but a good many of the lowland species will probably best be designated by trinominals after more collections come in from this little known region.

As in the case of the Bahamas, so also in Cuba, it is an unhappy fact that intensive collecting has been so long delayed. The changes which man has wrought over vast areas once high forest and now cattle pastures or cane fields make it uncertain whether we shall ever know as much as might have been learned had intensive collecting been carried

on a hundred years ago. So also is it equally certain that the attempts to monograph the faunas of the several islands were made too soon and innumerable published additions have been necessary to keep those who are interested informed of the constantly changing status of our knowledge of the animal life of the region. Here the senior author again has been seriously to blame. It is his hope, however, before long to bring out another check list of the reptiles and amphibians of the whole Antillean area, using trinominals where they have not been used before in an effort to indicate the particular relationships which are most conveniently expressed in this way but realizing at the same time that, in many cases, such use is inconsistent with the thesis that forms on separate islands, intergradation with geographic juxtaposition being impossible, are really species, zoologically speaking, and not subspecies in the sense in which the word is properly used. One hesitates to use the same method of designation for these island forms as one uses for geographic races on the continents or on the large islands where races which intergrade are found either in mountains and adjacent lowlands or in adjacent areas with regions of intergradations between them. It is not the inconsistency which is unpleasing but, rather, that the same method of designation is being used for two essentially different catagories.

The races described in this paper are forms which definitely have relationships within the Island of Cuba and hence these trinominals are bestowed with a clear conscience.

Celestus delasagra nigropunctata subsp. nov.

Plate 1

Type. M. C. Z. No. 42504 an adult female from the mountains north of Imias, about 3000 feet altitude, Oriente, Cuba, collected by P. J. Darlington, July 28, 1936.

Paratypes. M. C. Z. No. 7426 from Eastern Cuba, an old and somewhat faded individual with no further data or history; M. C. Z. No. 42563 from Cuchillo de Guajimero, about 2000 feet, Oriente, Cuba, and M. C. Z. No. 42506 from El Yunque de Baracoa, 1000-1800 feet, Oriente, Cuba both collected by P. J. Darlington, July 1936.

Diagnosis. Essentially similar to typical *delasagra* but differing in coloration (in alcohol). The back is rather black or very dark brown, especially anteriorly; there are very dark spots each often accompanied with a whitish one; the lateral band is black (dark brown in No. 7426) anteriorly this is broad, posteriorly it breaks up into black or dark

brown spots, extending on to tail, each is bordered above posteriorly by a narrow dark line in two of the paratypes; whitish spots on the lateral band tend to arrange themselves in vertical rows. The whitish spots are only distinct on anterior portion of this band in the paratypes. In paratype No. 42506 the dark lateral band is not present posteriorly its place being taken by a light gray area which does not extend on to the tail; in other respects the coloration is similar to that of typical *delasagra*.

Measurements.

		Length Head and Body	*Tail*	*Total Length*	*Hind Limb*	*Hind Foot*
Type No.	42504	111 mm.	143 mm.	254 mm.	19 mm.	9 mm.
Paratypes	7426	93 mm.			18 mm.	8 mm.
	42506	92 mm.	56 mm.	148 mm.	18 mm.	8 mm.
	42563	107 mm.	82 mm.	189 mm.	22 mm.	10 mm.

The tail of No. 7426 is broken. The tails of Nos. 42506 and 42563 are regenerated.

Remarks. More material may show that No. 42506 actually represents still another unrecognized race.

Dr. Darlington supplies the following field notes concerning the type (No. 42504). "It was curled around and among four eggs under a chunk of rotten wood about three feet by one foot and six inches thick which was lying rather loosely on the ground in a field close to the edge of woods at about 3000 feet elevation. I was told by children who showed me the nest that the lizard had been there for several days."

Two of the four eggs mentioned above were preserved and are now in the Museum of Comparative Zoölogy.

Sminthillus limbatus orientalis subsp. nov.

Plate **2**, fig. 1.

Type. M. C. Z. No. 22082 a female? from El Yunque de Baracoa, 1000–1800 feet, Oriente, Cuba, collected by P. J. Darlington, July 13–14, 1936.

Paratypes. M. C. Z. Nos. 22083–9 and two uncatalogued specimens with the same data and history as the type.

Diagnosis. Essentially similar to typical *limbatus* (Plate 2, fig. 2.) but differing in coloration (in alcohol). Back spotted with black or very dark brown, posteriorly especially; always a small dark shaped mark, or a dark spot in some paratypes, in the middle of back just in

front of the line of insertion of the fore limbs. These are preceded by two small dark dots (absent in one paratype); the white dorso-lateral streaks are prominently margined with black on their inner edges, except very anteriorly; dorso-lateral white streaks slightly converge and then slightly diverge anteriorly (little evidence of this in some paratypes); rear of femur marked with black (note that the black markings in the large specimens are dark brown in a juvenile). Otherwise the coloration is similar to that of typical *limbatus*. In *limbatus* the dorsal ground color is usually darker and the white streaks usually narrower than in *orientalis*.

Measurements.

	Length Head and Body	*Head*	*Hind Limb*	*4th Toe*
Type No. 22082	13 mm.	5 mm.	18 mm.	3 mm.
Paratypes 22083–9 and two uncatalogued specimens.	12–8 mm.	5–3 mm.	18–12 mm.	4–2 mm.

The figures show the difference of these two races. The typical form is much more richly colored, more maroon than the Baracoa race. The senior author is not wholly convinced that the genus Sminthillus is worth recognizing. The name, however, is preferred by the junior author, who may be entirely correct in his stand.

Eleutherodactylus turquinensis sp. nov.

Plate 3, fig. 1.

Type. M. C. Z. No. 21975, a female, from near Cueva del Aura, Turquino Peak, 1500–4000 feet, Oriente, Cuba, collected by P. J. Darlington, June 1936.

Paratypes. M. C. Z. Nos. 21976–21984 and twenty-two uncatalogued specimens all with the same data and history.

Diagnosis. Closely allied to *Eleutherodactylus sierramaestrae* and *E. brevipalmatus*, if these are entitled to separate recognition. It differs from both in possessing decidedly more webbing on the feet, a smoother dorsum, which is subject, of course, to the influence of preservation, and usually more rounded less truncate digital disks.

Description. Tongue suboval, slightly nicked behind (not nicked in some paratypes); vomerine teeth in two fairly long, slightly curved groups behind the choanae (straight in some paratypes), extending not quite so far as the outer edges of the choanae (extending about as far in some paratypes); snout subacuminate, slightly longer than the diameter of the eye (as long as diameter of eye in some paratypes);

loreal region concave, somewhat oblique; nostril nearer tip of snout than eye; interorbital space slightly broader than upper eyelid (interorbital space slightly narrower or about the same as the upper eyelid in most paratypes); tympanum distinct, one half the diameter of the eye (a bit less than one half to about three quarters in the paratypes); digital disks large, rounded or slightly pointed on the ends; disk of third finger almost as large as tympanum (as large as to about a quarter as large in the paratypes); first finger shorter than second; first toe much shorter than second; toes webbed at base, the web extending up the side of each digit as a *distinct dermal margin;* two metatarsal tubercles; the tibio-tarsal articulation of the adpressed hind limb reaches to just in front of the eye (reaches just in front of the eye to just behind it in the paratypes); slightly warty above, middle of back smooth (middle of back slightly warty in some paratypes); smooth below, granular on sides of belly.

Coloration in alcohol. Above, black or purplish brown, lips gray posteriorly with dark streaks radiating from the eye to the edge of the lip; limbs crossbanded with darker, also a darker crossband between the eyes; crossbands rather indistinct owing to the darkness of the ground color; ground color of femur lighter, with the crossbands more clearly evident; below, whitish, powdered and sparsely spotted with dark brown.

Ground color of upper surface of paratypes like that of type varying to light gray, the crossbands being more plainly evident in the lighter colored individuals. There is also a chevron-shaped dark marking on the anterior part of the dorsum of the lighter specimens. The upper surface of the head in some examples is lighter than the dorsum; also the labial streaks are sometimes obsolete. In one paratype, a light dorsolateral band is present on each side from the upper eyelid almost to the hind limb. Beneath the paratypes are similar to the type, or more or less heavily marked with a darker shade.

Measurements.

	Length Head and Body	*Head*	*Hind Limb*	*4th Toe*
Type No. 21975	53 mm.	19 mm.	83 mm.	16 mm.
Paratypes 21976–84	45–16 mm.	12–6 mm.	73–23 mm.	12–4 mm.

twenty-two uncatalogued specimens.

Remarks. Dr. Darlington reports that this species was found clinging to rocks in mountain streams and that he did not find it associated with any other habitat. He tells us that *E. sierra-maestrae* and *E. brevipalmatus* were often found on the banks of these streams,

but would take to the water if alarmed. Although similar mountain streams are to be found on other Cuban peaks, no form corresponding to *turquinensis* has been found in them. Darlington did consider that *sierra-maestrae* and *brevipalmatus* in the Cobre range were rather more aquatic than on Turquino Peak. He adds also that the new frog occurred in the tributaries of the Rio Potrerillo (1000 to 3000 feet) up to Rio Cabrera (probably above 3000 feet). It was not found at the mouth of Rio Potrerillo nor at mouth of Rio Turquino near sea level, none in the upper reaches of Rio Turquino at 4000 to 5000 feet, although the stream looked perfectly suitable and was of the same size as streams in which the frog did occur.

Eleutherodactylus atkinsi orientalis subsp. nov.

Plate 3, fig. 2.

Type. M. C. Z. No. 22158 a gravid female from Upper Ovando River, 1000–1200 feet, Oriente, Cuba, collected by P. J. Darlington, July 1936.

Paratypes. M. C. Z. No. 22159 with the same data and history as the type; M. C. Z. Nos. 3882 and 4073 from La Patana near Baracoa collected by V. J. Rodriquez, no date; M. C. Z. Nos. 22092–8 frp, Cape Maisi, July 15–16, 1936; M. C. Z. Nos. 22101–3 from Mountains North of Imias, 3000–4000 feet, July 25–28, 1936; M. C. Z. Nos. 22070–4 and two uncatalogued specimens from El Yunque de Baracoa 1000–1800 feet, July 13–14, 1936. All the localities are in the Province of Oriente, Cuba. All paratypes were collected by P. J. Darlington unless otherwise mentioned.

Diagnosis. Preserved in alcohol this form is essentially similar in alcohol to the typical *atkinsi* but it differs in possessing no conspicuous black spot or spots on the upper side of the femur near its base; only rarely in a few paratypes are a few very small black spots to be found on the rear of the femur or on its anterior side near the base. The light dorso-lateral light streaks in this new form start at the rear of the upper eyelid, whereas in typical *atkinsi* they usually start further down on the back, or may be wholly absent; also the dorso-lateral streaks are wider and more distinct then they usually are in *atkinsi*.

Note that the innermost of the brown femoral crossbands which are sometimes present must not be mistaken for the femoral spot.

Juvenile specimens of typical *atkinsi* often cannot be distinguished from those of *orientalis*.

Measurements.

	Length Head and Body	*Head*	*Hind Limb*	*4th Toe*
Type No. 22158	43 mm.	16 mm.	64 mm.	14 mm.
Paratypes 22159,	43–9 mm.	17–4 mm.	71–13 mm.	16–3 mm.

3883, 4073, 22092–8, 22101-3, 22070–4 and two uncatalogued specimens.

Remarks. Specimens of *atkinsi* from the following localities in Oriente: Cobre Range, Siboney, Santiago, and Guantanamo, in the Museum of Comparative Zoölogy are rather intermediate between typical *atkinsi* and *orientalis*. They possess the black femoral spot or spots found in *atkinsi* and a dorso-lateral band as in the new race.

Eleutherodactylus albipes sp. nov.

Plate **4**, figs. **1–2**.

Type. M. C. Z. No. 22045, a female, from Turquino Peak, 5400–6000 feet, Oriente, Cuba, collected by P. J. Darlington, June 1936.

Paratypes. M. C. Z. Nos. 22046–9 and twelve uncatalogued specimens with the same data and history as the type; M. C. Z. No. 21960 from near Cueva del Aura, Turquino Peak, 1500–4000 feet, June 1936; M. C. Z. Nos. 22015–8 from Cueva del Aura to "Pico Cuba," Turquino Peak, 3500–5000 feet, June 1936, all collected by Dr. Darlington.

Diagnosis. Allied to *Eleutherodactylus emiliae* from which the new form differs in having the dorso-lateral fold obsolete, and usually in possessing a more sharply defined supra-tympanic fold. Also *albipes* appears to grow slightly larger. This form also differs in coloration.

Description. Tongue suboval, not nicked behind; vomerine teeth in two very long groups, behind the choanae, each group extending about half their length beyond the choanae (in some paratypes vomerine teeth do not extend quite so far beyond choanae as in type; in very young specimens vomerine teeth are invisible); snout obtuse, slightly longer than the diameter of the eye; canthus rostralis distinct and slightly curved; loreal region concave and decidedly oblique; nostril slightly nearer the tip of snout than the eye or about the same distance in some paratypes; interorbital space broader than upper eyelid; tympanum distinct, about two thirds the diameter of the eye or about the same diameter to about one half in the paratypes; the tips of the digits are very feebly swollen or are not swollen at all; first finger is slightly shorter than the second or about the same length in some of the paratypes; the first toe is decidedly shorter than the second; the toes are practically unwebbed at the base. There are two

fairly prominent metatarsal tubercles, the inner the more prominent but they are about equally prominent in the juvenile paratypes. The tibio-tarsal articulation of the adpressed hind limb reaches to the shoulder or between the shoulder and the tympanum in the paratypes; smooth above; sides granular, an indistinct lateral fold, and a distinct supratympanic fold which is rather indistinct in some of the paratypes, perhaps due to the preservation. All are smooth below, and granular on the sides of the belly.

Coloration in alcohol. Above, dark brown, the hind limbs indistinctly crossbanded with darker; femur and hindside of humerus whitish yellow, somewhat washed with brown; feet and hands, both above and below, yellowish white. The outer digits are strongly marked with brown, the inner with less of this brown marking; below, whitish yellow, suffused and spotted with brown, on the suffused areas a few small whitish spots.

Above, the ground color of the paratypes may be either lighter or darker than the type, often grayish in juvenile specimens. The lighter specimens show crossbands on the hind limbs more distinctly than does the type. There is also a dark spot near the groin in many of the paratypes; the whitish-yellow areas on the limbs may be absent; sometimes these are faint, whitish, incomplete dorso-lateral streaks; also sometimes a broad whitish lateral streak; the paratypes generally more strongly suffused and spotted beneath with brown than is the type.

Measurements.

	Length Head and Body	*Head*	*Hing Limb*	*4th Toe*
Type No. 22045	33 mm.	11 mm.	40 mm.	9 mm.
Paratypes 22015–8	24–9 mm.	9–4 mm.	31–11 mm.	7–2 mm.

21960, 22046–9 and twelve uncatalogued specimens.

Eleutherodactylus intermedius sp. nov.

Plate **4.** figs. **3–4.**

Type. M. C. Z. No. 21965, a female, from near Cueva del Aura, Turquino Peak, 1500–4000 feet, Oriente, Cuba, collected by P. J. Darlington, June 1936.

Paratypes. M. C. Z. Nos. 21966–74 and four uncatalogued specimens with the same history as the type; M. C. Z. No. 22050 from Turquino Peak, 5400–6000 feet. June 1936; M. C. Z. No. 22157 from the Cobre Range 3000–3800 feet, July 1936; M. C. Z. Nos. 22130–2 from Mountains North of Imias, 3000–4000 feet, July 25–28, 1936. All collected in Oriente, Cuba by P. J. Darlington.

Diagnosis. Allied to *Eleutherodactylus albipes,* but differing in the shape and position of the vomerine teeth and in coloration. This new species appears decidedly smaller than *albipes.*

Description. Vomerine teeth in two rather long groups behind the choanae, reaching to about the level of the outer edges of the choanae or not quite so far as usual; the vomerine teeth are absent in some of the juvenile paratypes. There are a few small warts on the back and these are absent in some paratypes also. Otherwise this frog is essentially similar to *albipes,* the preceding species. Note, however, the very different coloration.

Coloration in alcohol. Above, light gray, mottled with brown and darker gray; an indistinct brown crossband between the eyes; a black band from tip of snout to eye extending along the canthus rostralis; another black band extending from eye along the supratympanic fold; limbs crossbanded with darker; a white line on rear of femur; below, dark brown, densely covered with irregularly shaped white or yellowish white spots; along the middle of the belly the spots tend to arrange themselves to form a broken line.

In coloration the paratypes are very variable. Above, the ground color ranges from being like that of type to very dark brown or black, in some cases variously marked or mottled with darker. The canthal band may be poorly defined or absent; the supratympanic band is sometimes also ill defined. Some paratypes have a broad dark brown lateral streak extending from eye to hind limb. The crossbands on limbs scarcely evident in some species. There are sometimes narrow whitish dorso-lateral streaks or a narrow whitish vertebral line, any of which may be incomplete, indistinct or absent. The anterior portion of the dorsal line is often bordered with brown. The light femoral streak may also be incomplete, indistinct, or absent. There is a black spot present near the groin in a few specimens and on the bellies white spots either more or less numerous than in type, may produce in places the effect of heavy brown markings on a white ground color. The ventral median white line, sometimes continuous, may appear beneath the head and chest as well as the belly but it may also be ill-defined or absent.

Measurements.

	Length Head and Body	*Head*	*Hind Limb*	*4th Toe*
Type No. 21965	19 mm.	7 mm.	22 mm.	5 mm.
Paratypes 22050	20–9 mm.	8–3 mm.	25–13 mm.	5–2 mm.

22157, 22130–2, 21966–74 and four uncatalogued specimens.

Eleutherodactylus parvus sp. nov.

Plate 2, figs. 3–4

Type. M. C. Z. No. 21947, a female, from Cueva del Aura, Turquino Peak, circa 3500 feet, Oriente, Cuba, collected by P. J. Darlington, June 1936.

Paratypes. M. C. Z. Nos. 21948–56 and six uncatalogued specimens with the same data as the type; M. C. Z. Nos. 21957–9 from near Cueva del Aura, Turquino Peak, 1500–4000 feet, Oriente, Cuba, collected by P. J. Darlington, June 1936.

Diagnosis. Similar to the preceding species from which it differs in the shape of the head, the shape and position of the vomerine teeth and in coloration; also, it is decidedly smaller. It may be allied also to *Eleutherodactylus varleyi* from which it differs in the shape and position of the vomerine teeth, in having decidedly shorter digits, and in being less warty above. All differ decidedly in coloration.

Description. Vomerine teeth in two rather short groups well behind the choanae, extending to about the level of the inner edges of the choanae (vomerine teeth not definable in some paratypes); loreal region almost vertical; tympanum about two thirds the diameter of the eye or only a bit more than one half to nearly as large in the paratypes; the tibiotarsal articulation of the adpressed hind limb reaches to the posterior border of the eye. It reaches from the tympanum to the posterior border of eye in the series of paratypes. All are slightly warty above; there is no lateral fold; otherwise this form is very similar to *E. albipes* described above.

Coloration in alcohol. Above, brown, hind limbs crossbanded with very dark brown; a whitish vertebral line on the dorsum connecting up with two other whitish lines each one extending across the rear of the femur; also a broad vertebral dark brown spot, irregular in outline, extending from about a level with the insertion of the fore limbs to the hind limbs; a broad crossband of the same color between and behind the eyes; a very dark brown or black spot on each side near the groin; a very dark brown, broad lateral streak extending from the tip of the snout to the hind limb, bending downward posteriorly; beneath, whitish, chest, throat, and underside of lower jaw powdered with brown; sides of belly very dark brown, this color being a continuation of the lateral streaks; middle or whitish portion of belly spotted with dark brown; under side of femur dark brown minutely spotted with whitish.

Above, in some of the paratypes, the ground color may be quite

dark so that the markings are less distinct; crossbands of hind limbs sometimes lighter colored than in type; dark vertebral spot very variable in shape and size, sometimes merging with the crossband between the eyes and sometimes entirely absent; crossband between the eyes often absent or indistinct; dorsal and femoral white lines may be absent or indistinct; below, the specimens may be colored as described for the type or the whitish areas may be very little marked with brown or else so heavily marked that the whitish regions are almost completely obscured. Occasionally the underside of the femur is marked with large whitish patches.

Measurements.

	Length Head and Body	*Head*	*Hind Limb*	*4th Toe*
Type No. 21947	13 mm.	6 mm.	18 mm.	4 mm.
Paratypes 21957–9	14–9 mm.	5–4 mm.	19–14 mm.	4–2 mm.

21948–56 and six uncatalogued specimens.

EXPLANATION OF PLATES

All figures by E. N. Fisher

PLATE 1

Plate 1

Celestus delasagra nigropunctata. Type.

PLATE 2

Plate 2

Fig. 1. *Sminthillus limbatus orientalis*. Type.
Fig. 2. *Sminthillus l. limbatus* from Soledad, Cienfuegos, Cuba.
Fig. 3. *Eleutherodactylus parvus*, upper side.
Fig. 4. *Eleutherodactylus parvus*, lower side.

1

2

3

4

PLATE 3

Plate 3

Fig. 1. *Eleutherodactylus turquinensis.* Type.
Fig. 2. *Eleutherodactylus atkinsi orientalis.* Type.

2

1

PLATE 4

Plate 4

Fig. 1 & 2. *Eleutherodactylus albipes.* Type.
Fig. 3 & 4. *Eleutherodactylus intermedius.* Type.

1

2

3

4

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
Vol. LXXX, No. 10

UPPER JURASSIC AND LOWER CRETACEOUS AMMONITES OF THE MALONE MOUNTAINS, TRANS-PECOS TEXAS

By Claude C. Albritton, Jr.

With Nine Plates

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
September, 1937

No. 10.—*Upper Jurassic and Lower Cretaceous Ammonites of the Malone Mountains, Trans-Pecos Texas*

By Claude C. Albritton, Jr.

INTRODUCTION

The Malone Mountains are located in southern Hudspeth County, Texas, and may be found on the Fort Hancock topographic sheet. Since 1890 the marine invertebrate fauna enclosed in the Mesozoic rocks of this small desert range and its satellite hills has attracted the attention of paleontologists and collectors. To date the most comprehensive account of the paleontology is that of F. W. Cragin (1905, pp. 34–109, Pls. I–XXIX)[1], who has described many new species from the area. Most of Cragin's specimens were collected about a mile northeast of the Malone Mountains from low, outlying hills known as the Malone Hills.

Cragin believed that the entire sedimentary sequence of the Malone Hills and Mountains was of Jurassic age. Accordingly, he named this sequence the Malone formation, correlating it, on the evidence of ammonites, with the Tithonian of Europe. More recently, however, F. L. Kitchin (1926) has suggested that a part of Cragin's Malone formation is of Lower Cretaceous age, and C. L. Baker (1927, p. 11) has cited evidence for the presence of Permian strata in the area.

In an attempt to solve the stratigraphical problems of the area, the writer in the summers of 1934 and 1935 made an intensive study of 63 square miles centering around the Malone Hills and Malone Mountains. This survey was supervised by Professor M. P. Billings of Harvard University, and conducted with the able assistance of Messrs. C. C. Albritton, Sr., J. Fred Smith, Jr., and J. D. Boon, Jr. Fossils were collected from some 25 carefully measured sections, so that for the first time it is possible to refer individual species to their precise horizons and thus determine the geological ages of the several formations in the area.

The writer's collection includes more than a hundred specimens of ammonites. Careful study of these, under the direction of Professor P. E. Raymond, has shown that thirteen species are represented. Of these, five are new and four have not been previously reported from the area. The abundant material at hand has, in addition, provided significant new data on previously described species. Accordingly, the writer presents in the following paragraphs a complete account of the

[1]Numbers in parenthesis refer to papers listed in the bibliography.

ammonites. Where taxonomic revision has been necessary, he has been guided by the published comments of Burckhardt, Spath, Uhlig, and Adkins, acknowledged in the descriptive portions.

Since there is at present no accurate published account of the stratigraphy of the area, it is necessary to include the following generalized section, to which the fossils may be referred.

General Stratigraphical Section of Malone Mountains and Outlying Hills

Quaternary and Tertiary	Thickness in feet
Basin-fill (sand, clay, and gravel)	0–100+
.....Unconformity.....	
Lower Cretaceous	
Glen Rose formation — thin-bedded, impure limestone with interbedded sandstone and grit	750+
(Unexposed)	1500
Las Vigas (?) formation — red, sandy shale, impure limestone, and limestone-pebble conglomerate	50+
(Unexposed)	500
Torcer formation (emended) — impure limestone, sandstone, and sandy shale, with basal quartzitic sandstone and chert-pebble conglomerate	400+
Upper Jurassic	
Malone formation (emended)	
Upper Division — black limestone with local sandy beds toward top	150–330
Lower Division — thin-bedded sandstone, sandy shale, impure limestone, and limestone conglomerate	0–685
.....Unconformity.....	
Permian	
Briggs formation — gypsum with interbedded limestone	630+

DESCRIPTIONS OF SPECIES

Family HAPLOCERATIDAE Zittel

Genus Haploceras Zittel

Haploceras cragini spec. nov.

Plate I, figs. 3, 4; Plate V, figs. 1–4

Oppelia (?) fallax (Cragin) not Castillo and Aguilera, U. S. Geol. Survey Bull. 266, 1905, pp. 101–102, Pl. XXII figs. 2, 3.

Specific Characters. Coiling oligogyral, serpental; subangustumbilicate. Sides convergent, feebly to moderately convex; venter arched. Whorls compressed. Umbilical wall high in variety with relatively depressed whorl-section, low in variety with relatively compressed whorl-section; rounded in both instances.

Shell smooth, with faint flexuous striae arising at the planispiral suture, inclined slightly backward as they traverse the umbilical slope, above which they are deflected slightly forward. Most of the striae disappear before reaching the venter. Striae entirely lacking in some specimens; apparently this is more often the case in the relatively depressed than in the relatively compressed variety.

Suture lines complex, interlocking, with large unsymmetrical, trifid, first lateral lobe the dominant element.

Measurements.[1]

Variety a. (Whorl-section relatively compressed)				
A.	140	42%	25%	22%
B.	117	38%	23%	20%
C.	130	43%	30%	23%
D.	80	44%	31%	21%
E.	115	40%	31%	23%
F.	182	38%	27%	23%
Variety b. (Whorl-section relatively depressed)				
G.	90	46%	35%	21%
H.	134	42%	36%	25% (?)
I.	42	50%	35%	15% plus

[1]All measurements are cited in the conventional order, from left to right: (1) Diameter in mm. (2) Height of outer whorl as % of diameter (3) Thickness of outer whorl as % of diameter, and (4) width of umbilicus as % of diameter.

Observations. Two varieties, distinguished only by relative compression of whorl-section, were found associated wherever this species was collected.

Cragin (1905, pp. 101–102, Pl. XXII, figs. 2, 3) has described the young stage of variety b. This he referred to *Placenticeras fallax* Castillo and Aguilera, reassigning the species to the genus *Oppelia* (?).

Consideration of several excellent specimens at hand shows that the Malone species differs from *Placenticeras fallax* as described by Castillo and Aguilera (1895, p. 17, Pl. VIII, figs. 1, 2) in wider umbilicus and presence of striae on the later whorls. Moreover, the Malone species lacks the angulation at the margin of the umbilical slope, a feature which is not mentioned in the verbal description of Castillo and Aguilera, but which is readily apparent in the figures.

In generic assignation of this species Cragin wavered between *Oppelia* and *Haploceras*:—

"As it makes some departures from the characters belonging to most of its congeners, this ammonite may seem at first sight almost as much of an anomaly in the genus *Oppelia* as it was supposed to be in *Placenticeras*. But the suture, which has the lobes and saddles very few instead of many, and has the first lateral lobe contrastingly the largest, sufficiently distinguishes it from the latter genus and relates it to *Oppelia* and *Haploceras*, with which also agree its . . . compressed lenticular form, and the absence of periodical constrictions. It seems indeed to have its closest affinities and to belong among the round-ventered, phylogerontic forms of *Oppelia* which occur in the latest Jurassic rocks, in which this genus makes its final appearance; the venter, in *O. fallax*, being rounded both on the outer and on the inner whorls." (Cragin, 1905, p. 102.)

Indeed the difficulty in distinguishing between *Oppelia* and *Haploceras* first arose in the mind of Zittel, who in founding the latter genus observed that the length of living chamber, large siphonal sheath, and suture pattern were confusingly similar in the two genera. (Zittel, 1870, pp. 48–49.)

Among the more important distinguishing characteristics, however, Zittel emphasized the unornamented, laevigate or finely striate shell of *Haploceras*, and it is largely on this basis that the Malone species is here referred to *Haploceras* rather than *Oppelia*.

Insofar as the writer is aware, *Haploceras cragini* is not likely to be confused with any previously described species. It may be distinguished from *H. fialae* Oppel by the absence of a spiral furrow. From *H. transatlanticum* Burckhardt, *H. zacatecanum* Burckhardt,

H. mexicanum Burckhardt, *H. costatum* Burckhardt, and *H. ordonezi* Aguilera, all from the Jurassic of Mexico, *H. cragini* may be distinguished by the convergence of the lateral areas and the weakness of the striae. The more compressed whorl-section and more narrowly rounded venter serve to separate the Malone species from *H. staszycii* Zeuschner, *H. elimatum* Oppel, *H. indicum* Uhlig, and *H. verruciferum* Meneghini. The smooth, uncrenulated venter of the Texas species differentiates it from *H. tomephorum* Zittel, *H. rhinotomum* Zittel, and *H. carachtheis* var. *subtilior* Zittel. From *H. rasile* Zittel, *H. cragini* is readily distinguished by the convergence of the lateral areas.

H. cragini is restricted to the lower division of the Malone formation. Fragmentary specimens are abundant at the southeastern end of the Malone Hills, and more complete ones may be collected along the southwestern side of the Malone Mountains. Holotype (M. C. Z. 3861) from Ammonite Canyon, Malone Mountains.

Family STEPHANOCERATIDAE Neumayr emend. Zittel

Genus Idoceras Burckhardt

Idoceras schucherti (Cragin)

Plate II, fig. 1, Plate V, figs. 6, 7

Perisphinctes schucherti Cragin, U. S. Geol. Surv. Bull. 266, 1905, pp. 107–108, Pl. XXV, fig. 1, XXVI, figs. 1–3, XXVII, fig. 1.

Specific Characters. Coiling polygyral, serpental, subangust-umbilicate. Sides plano-convex, whorl-section compressed; venter arched, with tendency to become slightly tabulate in some specimens. Subgradumbilicate.

Early whorls (at least first five) with closely-set costae bifurcating or trifurcating at about the middle of the flanks into feebly divergent smaller branches inclined slightly forward.

Costation greatly reduced with increase in size of shell, disappearing first from the middle of the flanks, then from the umbilical slopes, and finally, in at least one specimen, from the ventral region. Most specimens, however, maintain weak ribbing in the ventral area, where the ends of the costae are interrupted by a smooth band. Costae with alternate arrangement on opposite sides of venter. Constrictions large, shallow, at remote intervals.

Suture lines fairly complex with broad siphonal and dominant

first lateral lobe. Lateral lobes trifid, regularly decreasing from second lateral lobe toward the planispiral suture.

Measurements.

A.	135	40%	20%	28%
B.	147	36%	18%	33%
C.	168	40%	19%	24%

Observations. Burckhardt has compared *Idoceras schucherti* with two closely related forms from the Kimmeridgian of San Pedro del Gallo: *I. lorioli* Burckhardt and *I. cragini* Burckhardt. With reference to *I. lorioli* Burckhardt has written:

"A closely related species appears to be *Perisphinctes schucherti* Cragin *pro parte* (Cragin, l.c. p. 107, Pl. XXV, fig. 1, Pl. XXVI, fig. 1). The Texas species may be distinguished from the Mexican form by its thicker whorls and broader umbilicus. It hardly need be said that the Malone species has absolutely nothing in common with either *Perisphinctes inconditus* Font. or *Olcostephanus potosinus* Castillo and Aguilera, forms with which Cragin sought to ally his species." (Burckhardt, 1912, p. 111 — translation.)

Burckhardt could detect no appreciable differences between the specimen of *Idoceras schucherti* figured on Plate XXVII of Cragin's bulletin and *Idoceras cragini*, but refrained from referring his Mexican form to Cragin's species because of the inadequacy of the latter's figures and descriptions. (Burckhardt, 1912, pp. 119–120.)

Specimens of *Idoceras schucherti* in the writer's collection clearly exhibit the close relationship of this species to *I. cragini*, as suggested by Burckhardt. The dimensions of the Texas and Mexican forms differ by negligible percentages (2% to 5%), and the suture patterns are strikingly similar. On the other hand, the writer believes that the two forms should be maintained as distinct species for the following reasons.

1. *Idoceras schucherti* exhibits a more pronounced tendency toward complete reduction of ornamentation with increasing size than does *I. cragini*.

2. The length of the second lateral lobe of *I. cragini* more nearly approaches that of the first lateral lobe than is the case in the Malone species.

3. The third and succeeding lateral lobes of *I. cragini* are more strongly inflected toward the first lateral lobes than are those of *I. schucherti*.

Idoceras schucherti (Cragin) is restricted to the lower division of the Malone formation, in which it is comparatively rare. Plesiotype (M. C. Z. 3863) from Ammonite Canyon, Malone Mountains.

Idoceras clarki (Cragin)

Plate III, fig. 1, Plate V, figs. 5, 8, 9

Perisphinctes clarki Cragin, U. S. Geol. Surv. Bull. 266, 1905, pp. 103–105, Pl. XXIX, figs. 1, 2.

Specific Characters. Coiling polygyral, serpental, subangustumbilicate to sublatumbilicate. Whorls compressed; sides feebly to moderately convex; venter arched. Subgradumbilicate.

First several whorls (7 to 9) with sharp, closely set, anteriorly inclined costae arising at the planispiral suture, bifurcating or trifurcating slightly above mid-points of sides, and interrupted along the venter by a narrow, smooth band. Branches with alternate arrangement at venter. Occasional narrow constrictions bounded on one side by unbranched ribs parallel the costae. Ornamentation gradually disappears with age; living chamber smooth or traversed by a few broad undulations.

Suture-lines fairly complex. Broad-trunked siphonal lobe indented by broad, weakly-indented, trifid, median saddle. Lateral lobes narrow, trifid. First lateral lobe the major sutural element: about twice the length of second lateral lobe.

Measurements.

A.	188	37%	21%	33%
B.	83	33%	21%	40%
C.	235	33%	19%	40%
D.	265	33%	19%	39%

Observations. In his discussion of this species Cragin (1905, p. 105) makes the following observations:

"It is not unlikely that this is the same species as that figured and briefly described from the Tithonian of Mexico as "*Perisphinctes*" sp. (?) by Castillo and Aguilera, and compared by them in its ribbing with *P. lictor, P. haliarchus,* and *P. polygyratus.* The septal line bears considerable resemblance to that of the latter species, which, from the White Jura Beta, Quenstedt figures under the name of "*Ammonites triplicatus albus.*"

In the writer's opinion, however, the description and figure of the Tithonian fragment are insufficient for adequate comparison. (See Castillo and Aguilera, 1895, p. 35, Pl. XIX.)

Moreover, although the sutures of "*Ammonites triplicatus albus*" are broadly similar to those of *Idoceras clarki,* Quenstedt's species does not show the notable diminution in costation with increase in size exhibited by the Malone species. (See Quenstedt, 1888, Pl. 100, fig. 8.

On the other hand, *Idoceras clarki* appears to be closely related to *I. durangense* Burckhardt from the Kimmeridgian of San Pedro del Gallo (Burckhardt, 1912, p. 107, Pl. XXVI). The dimensions of the two species differ within small percentages, the suture-lines are practically identical, and both forms exhibit a strong tendency toward complete loss of ornamentation with increase in size. *Idoceras durangense*, however, retains weak ventral costae in the more advanced stages of growth, whereas even this feeble ornamentation is lost at comparable stages of the Malone species.

Idoceras clarki is restricted to the lower division of the Malone formation, in which it is comparatively abundant. Plesiotype (M. C. Z. 3864) from Ammonite Canyon, Malone Mountains.

Genus Lithacoceras Hyatt

Lithacoceras malonianum (Cragin)

Plate I, fig. 2, Pl. II, fig. 2, Plate VI, figs. 1–3

Olcostephanus malonianum Cragin, U. S. Geol. Survey Bull. 266, 1905, p. 103, Pl. XXIV, figs. 1, 2.

Perisphinctes potosinus Cragin (not Castillo and Aguilera) ibid., pp. 105–106, Pl. XXIII, fig. 1.

Perisphinctes felixi Cragin (not Castillo and Aguilera) ibid., pp. 106–107, Pl. XXIII, fig. 2.

Specific Characters. Coiling polygyral, serpental, sublatumbilicate. Whorl-section depressed in young stages, becoming less so with increase in size; slightly compressed in later whorls. Sides faintly to moderately convex; venter broadly rounded. Subgradumbilicate.

Sides with closely set, sharply defined costae arising at the planispiral suture, traversing the flanks inclined slightly forward, and branching near the middle of the sides into feebly divergent ribs which cross the venter uninterruptedly, at least in the septate portions of the shell. Costae of the first four to six whorls close-set, dominantly bifurcating, occasionally simple, trifurcating, or intercalated. Succeeding whorls with progressively larger and more widely spaced primary costae, with a correspondingly greater number of ventral branches per lateral costation. Largest whorl-fragment observed (height 90 mm.; breadth 85 mm. — septate portion of shell) with at least four and possibly more ventral branches per lateral costation. Somewhat smaller whorls bear dominantly trifurcating ribs. Constrictions shallow and widely spaced.

Suture-lines complex. Siphonal lobe the dominant element in early stages (at least in second and third whorls), later surpassed in length by the first lateral lobe, which is extremely broad-trunked in comparison with succeeding lobes. Lateral lobes trifid; external saddles bifid, narrowly constricted near their bases by branches of the adjacent lobes.

Measurements.

A. 165	. 25%	. 34%	. 46%
B. 125	. 24%	. 37%	. 47%

Observations. Consideration of the large suite of specimens at hand shows that the forms designated by Cragin as *Perisphinctes felixi P. potosinus,* and *Olcostephanus malonianus* represent successive growth stages of a single species of *Lithacoceras.* It is hardly necessary, therefore, to compare the Malone species with the Mexican forms to which Cragin supposed it was allied.

In the younger stages, the shells of *Lithacoceras malonianum* (with bifurcating costae) are indistinguishable from those of the Kimmeridgian form designated as *Perisphinctes mclachlani* by Burckhardt (1906, pp. 24–25, Pl. IV, figs. 407). The Mexican species was defined on the basis of a single internal cast with the following measurements: 60 . 30% . 35% . 51%. At comparable stages of development the sutures of the Texan and Mexican forms are identical, insofar as can be judged from Burckhardt's tracings. As has been noted, however, the adult suture of *Lithacoceras malonianum* exhibits considerable modifications of the early suture pattern — the first lateral lobes become longer than the siphonal lobe, and the saddles become greatly constricted at their bases.

Burckhardt notes a weakening or notching of the costae as they cross the venter. This is likewise characteristic of the internal casts of *Lithacoceras malonianum,* but wherever the shell is preserved, the ribs are seen to traverse the siphonal area without any weakening whatsoever. (See in this connection Cragin, 1905, Pl. XXIV, figs. 1, 2.)

These facts indicate a close relationship between the two forms in question; indeed the evidence cited favors the hypothesis that *Perisphinctes mclachlani* Burckhardt in an immature specimen of *Lithacoceras malonianum* (Cragin).

Lithacoceras malonianum is restricted to the lower division of the Malone formation. It is fairly abundant near the top of this division. Plesiotypes (M. C. Z. 3865, 3866) from Ammonite Canyon, Malone Mountains.

Lithacoceras shuleri spec. nov.

Pl. III, fig. 2; Pl. VII, figs. 1, 2, 4

Specific Characters. Coiling polygyral, serpental, sublatumbilicate (?). Whorls compressed, markedly so in young stages; largest whorl-fragment at hand almost equidimensional. Subgradumbilicate. Venter narrowly rounded to fastigate.

Early whorls with pronounced, narrowly rounded costae arising at the planispiral suture and traversing the sides inclined slightly forward, remaining single or parting into two narrowly divergent branches which are opposed on opposite sides of the sharpened venter. With increase in size the lateral costae become more pronounced and more widely spaced. The ventral costae, however, remain closely and regularly spaced, two to four of them corresponding to a single lateral rib. With still further increase in size, the ventral costae disappear, and the lateral ones assume the form of prominent bullae. Living chamber unknown.

Suture lines complex, with narrow, trifid, first lateral lobes the dominant elements. These are, however, only a little longer than the siphonal lobe. External saddles bifid, narrowly constricted by branches of the adjacent lobes.

Measurements. No complete specimens were collected. The dimensions of several whorl-fragments are given below.

	Height	Breadth
A.	27 mm.	22 mm.
B.	90 mm.	86 mm.
C.	67 mm.	73 mm.

Observations. *Lithacoceras shuleri* appears to be more closely related to *L. malonianum* (Cragin) than any other species the writer has found cited in the literature: this despite the marked differences in whorl-section, the more prominent lateral costation, and more rapid loss of ventral costae in *L. shuleri*. The sutures of the two species are almost identical; indeed they cannot be distinguished except perhaps by the more complete strangulation of the external saddles of *L. shuleri* by branches of the external and first lateral lobes.

Lithacoceras shuleri is restricted to the lower division of the Malone formation, in which it is rare. The holotype (M. C. Z. 3867) was collected at Ammonite Canyon in the Malone Mountains.

Genus Kossmatia Uhlig

Kossmatia aguilerai (Cragin)

Plate VIII, figs. 2, 6

Perisphinctes aguilerai Cragin, U. S. Geol. Surv. Bull. 266, 1905, p. 105, Pl. XXVIII, figs. 1, 2.

Specific Characters. Coiling polygyral, serpental. Whorls compressed, with feebly convex flanks and arched venter. Subgradumbilicate.

Flanks traversed by prominent, round-topped costae, which arise at the planispiral suture, ascend the umbilical wall inclined slightly backward, and traverse the flanks in the form of shallow, anteriorly-convex arches which bifurcate above the middle of the flanks. Secondary costae of opposite sides meet on the periphery approximately at right angles. Costae slightly elevated at loci of bifurcation.

Suture lines moderately complex; patterns unknown.

Measurements. (known only from whorl-fragments)

	Height	Breadth	B/H%
A. (Cragin)	107 mm.	84 mm.	79%
B. (Cragin)	57 mm.	50 mm.	87%
C.	54 mm.	41 mm.	75%
D.	45 mm.	34 mm.	75%

Observations. In his review of Cragin's bulletin, Uhlig noted that this species appeared to belong to the group of *Perisphinctes richteri* Oppel, a widely-distributed east-Indian and European group of Tithonian age, one which he had previously assigned to the genus *Kossmatia*. (Uhlig, 1910, pp. 267–268; 1907, pp. 285–286.)

Judging from a comparison of Cragin's figures and descriptions, Spath agreed with Uhlig in the assignment of the Malone species to *Kossmatia* (Kitchin, 1926, pp. 254 ff.). The writer can find no features in the specimens at hand which negative this diagnosis.

Owing to the extremely fragmentary condition of the specimens in the writer's collection and those previously described by Cragin, the following comparisons are necessarily incomplete and liable to error.

From *Kossmatia pectinata* Burckhardt and *K. interrupta* Burckhardt, the Malone species may be distinguished by its more broadly rounded venter. (Burckhardt, 1912, pp. 135–136, Pl. XXXIV, figs. 1, 7–10, 14; pp. 134–135, Pl. XXXIV, figs. 2–3, 15.)

The ventral costae of *K. aguilerai* are inflected more strongly

forward than are those of *K. burckarti* (Burckhardt, 1906, p. 133, Pl. XXXVII, figs. 2, 10).

From *K. santarosanus* Burckhardt the Malone species may be distinguished by its broader venter and less flexuous lateral costae. (Burckhardt, 1906, p. 129, Pl. XXXV, fig. 104.)

K. aguilerai appears to be closely related to *K. victoris* Burckhardt from the upper Portlandian of Mazapil. There is a tendency, however, for the lateral costae to become more broadly spaced with increase in size in *K. aguilerai* than in the Mexican form. (Burckhardt, 1906, p. 131, Pl. XXXVI.)

At least with respect to ornamentation *K. aguilerai* is closely related to *K. flexicostatus* Castillo and Aguilera, although comparison with this and other of the Catorzan species is hindered by the inadequate illustrations of the latter. (Castillo and Aguilera, 1895.)

Kossmatia aguilerai is restricted to the upper division of the Malone formation. Plesiotypes (M. C. Z. 3875 and 3876) from southwestern side of Malone Mountains near Cedar Canyon.

Kossmatia zacatecana Burckhardt

Plate VII, fig. 3

Kossmatia zacatecana Burckhardt, Bol. del Inst. Geol. de México, No. 29, 1912, pp. 136–138, Pl. XXXIV, figs. 4, 5, 6, 11, 12, 13, 16, 17, 20.

Specific Characters. Following is a translation of Burckhardt's original description, to which the Malone specimens appear to conform in every essential detail.

"The internal whorls are similar, both in form and ornamentation, to certain *Reineckia*. The test is somewhat thick, composed of slightly embracing whorls. The sides are narrow but the ventral area is unusually broad and feebly convex. The whorl section is depressed. The sides are covered with strong, linear, slightly oblique costae. They are uncrowded, and give rise about the middle of the flanks to two or three much less prominent secondary costae. At the points of branching the primary costae are elevated to form narrow lamelliform prominences or tubercles. There are occasional intercalated secondary costae and simple primary costae. The ventral costae are inclined slightly forward, those of opposite sides forming large angles with apices at the siphonal line, where the costae are considerably weakened but not completely effaced.

The larger whorls of our specimens show notable differences when compared with the previous ones. The general form, it is true, is still depressed. But the ornamentation now consists of strong and widely spaced primary costae inclined obliquely forward and bifurcating about the middle of the flanks into secondary costae likewise inclined anteriorly.

Where there are three secondary branches, the division is almost always virgatotomous. The secondary costae are more clearly directed forward than is the case in the younger whorls, and are more clearly depressed in the siphonal tract.

The constrictions are not prominent.

External lobe not very broad, a little deeper than the first lateral lobe. The latter is thin and symmetrical with three principal branches. The second lateral lobe is small, slightly oblique, and trifid. It forms a weakly developed sutural lobe with two or three pointed auxiliaries. External saddle broad, divided at its summit into two unequal branches, of which the external one is the larger. First lateral saddle narrow, divided by a secondary lobe directed obliquely forward into two unequal parts of which the external one is the higher. Second lateral saddle low and small, trifid at its summit.

The species is closely related to *K. pectinata*. It is distinguished by its broader whorls, more narrow umbilicus, by the greater number of tripartate costae, and finally by the slighter inflection of the costae."

Measurements.

A. Original of Burckhardt.....25 . 38% . 54% . 48%

B. Malone specimen — not reliable owing to distortion of fragmentary test.

Observations. The specimen at hand agrees with the above description in every observable particular with the exception that the larger whorls are slightly compressed rather than depressed. Burckhardt's specimens, however, do not show this advanced stage of development, so that the change from depressed to compressed whorl-section is probably to be attributed to normal ontogenetic development of the Mexican species.

The holotype is from the Upper Portlandian near Casa Sotelo, Santa Rosa, Mazapil, Mexico. In the Malone area the species is restricted to the upper few feet of the upper division of the Malone formation. Plesiotype (M. C. Z. 3877) from west bank of Iris Canyon, Malone Mountains.

Family ASPIDOCERATIDAE Zittel

Subfamily ASPIDOCERATINAE Zittel emend. Spath

Genus Physodoceras Hyatt

Physodoceras smithi spec. nov.

Plate I, fig. 1, Plate VIII, figs. 1, 3

Aspidoceras alamitocensis Cragin (not Castillo and Aguilera), U. S. Geol. Survey Bull. 266, 1905, p. 109, Pl. XXVII, fig. 2.

Specific Characters. Coiling oligogyral, serpental, subangustumbilicate. Whorls inflated, sides convex. Whorls depressed with arched venters. Subgradumbilicate.

Shell densiflexistriate; unituberculate, with row of nodes or bullae surrounding the umbilical margin (13 on outer whorl of specimen figured). Tubercles closely and regularly spaced on earlier whorls, with tendency to become irregularly spaced on later whorls. Low, poorly defined undulations rising at and between the tubercles of the outer whorl cross the venter uninterruptedly.

Suture lines moderately complex with regularly decreasing bifid saddles.

Measurements.

A. (Holotype)	105 mm.	42%	57%	29.5%
B.	140 mm.	40%	49.5%	30%

Observations. Cragin (1905, p. 109, Pl. XXVII, fig. 2) has referred a fragmentary specimen of this species to *Aspidoceras alamitocensis* Castillo and Aguilera. As compared with the Mexican species, however, *P. smithi* has a single rather than a double row of tubercles, is more narrowly umbilicate, and has a considerably more depressed whorl-section.

The relatively depressed whorl-section, strong development of the inner series of tubercles, broad, slightly-dissected saddles, and large size of shell are sufficient to distinguish the species from any of the closely related unituberculate Kimmeridgian species of the Mexican Jurassic.

P. smithi is restricted to the lower division of the Malone formation. It is comparatively abundant at Ammonite Canyon, where the holotype (M. C. Z. 3869) was collected.

Physodoceras booni spec. nov.

Plate IV, fig. 2

Specific Characters. Coiling oligogyral, serpental, subangustumbilicate. Whorls depressed with arched venter. Subgradumbilicate.

Shell densiflexistriate; unituberculate, with row of conspicuous nodes encircling the umbilical border. Venter of outer whorl crossed by a few, poorly-defined, irregular, undulations.

Sutures fairly complex with comparatively narrow bifid saddles decreasing in size with apparent regularity away from the venter.

Measurements. 90 mm. . 50% . 64% . 28%

Observations. *Physodoceras booni* appears to be rather closely related to *Aspidoceras contemporaneum* Favre, as described by Burckhardt (1906, pp. 32–34, Pl. V, fig. 104) from the zone of *Idoceras* at Mazapil. From this species, however, *P. booni* may be distinguished by its more depressed whorls and fewer, larger nodes.

The new species may be distinguished from the superficially similar Kimmeridgian species, *Aspidoceras psuedomicroplum* Burckhardt and *A. pavlowi* Burckhardt by its more depressed whorls and total lack of outer series of nodes. (Burckhardt, 1912, pp. 78–81, Pl. XIX, figs. 1–10.)

From *Physodoceras smithi*, *P. booni* is readily distinguished by its fewer, larger tubercles, and more depressed whorl-section.

P. booni closely resembles Favre's figures of *Ammonites liparus* Oppel, apparently differing from this species only in its more depressed whorls and in minor details of what little of the sutures is figured (Favre, 1875, pp. 46–47, Pl. figs. 4a–b). Oppel's figure of the same species, however, shows further and more pronounced differences in the presence of spines in the case of *A. liparus* as opposed to nodes in the case of the Malone species (Oppel, 1862, p. 22, Pl. 59, fig. 1). Considered collectively, therefore, the differences in whorl-section, ornamentation, and sutures are sufficient to warrant specific separation of *A. liparus* and *P. booni*, although the two forms are certainly very closely allied.

Physodoceras booni is restricted to the lower division of the Malone formation, in which it is fairly common. The holotype (M. C. Z. 3871) was collected at Ammonite Canyon in the Malone Mountains.

PHYSODOCERAS BAKERI spec. nov.

Plate VIII, fig. 4

Specific Characters. Coiling oligogyral, serpental, subangustumbilicate. Whorls depressed, venter arched, sides convex. Umbilicus deep; umbilical wall almost vertical with narrowly rounded margin. Shell laevigate. Unituberculate, with row of prominent nodes encircling the umbilical margin. Nodes grow more prominent, spinose, and radially elongate with increase in size of whorl. External row of nodes lacking on all, including the earliest (second) whorl examined.

Sutures fairly complex; saddles broad, bifid, with rounded terminations.

Measurements. 43 mm. . 48% . 90% . 25%

Observations. *Physodoceras bakeri* is readily distinguished from associated Malone species by its smaller size, relatively broader whorls, and deeper, narrower umbilicus.

In breadth of whorl, general size, and umbilication *P. bakeri* presents certain analogies to *Aspidoceras cyclotum* Steuer, described by Burckhardt from the Lower Portlandian of Mazapil (1906, p. 119, Pl. XXXII, figs. 3–6). From this and associated lower Portlandian species of Mexico, *P. bakeri* is distinguished by the presence of tubercles.

The tuberculation recalls that of *Aspidoceras contemporaneum* Favre described by Burckhardt (1906, p. 32, Pl. V, figs. 1–4) from the Kimmeridgian of Mazapil. The Mexican species, however, has more compressed whorls and smaller tubercles.

With regard to ornamentation, *P. bakeri* appears to stand about midway between *Aspidoceras avellanoides* Uhlig and *A. liparus* Oppel, the nodes of the Malone species being much larger and more closely spaced than those of the former, and less conspicuous than the spines of the latter (Uhlig, 1903, pp. 75–76, Pl. III, figs. 1a–e; Oppel, 1863, p. 220, Pl. LIX, fig. 1). *P. bakeri* differs from both the above species in its more depressed whorl-section.

P. bakeri is restricted to the lower division of the Malone formation, in which it is rare. The holotype (M. C. Z. 3870) was collected southeast of Gypsum Switch in the Malone Mountains.

Genus Aspidoceras Zittel

Aspidoceras cf. laevigatum Burckhardt

Plate VIII, fig. 5

Aspidoceras laevigatum Burckhardt, Bol. del Inst. Geol. de México, No. 29, 1912, pp. 81–82, Pl. XX, figs. 2, 4, 9.

Included in the writer's collection are fragments of robust, smooth-shelled ammonites which (judging by their form and what little can be observed of the sutures) are referable to *Aspidoceras laevigatum* Burckhardt from the Kimmeridgian of San Pedro del Gallo.

The fragments show no nodes, only broad undulations, on the outer whorls. Inner whorls show almost imperceptible, rather closely-spaced undulations crossing the venter. Unfortunately, the dorsal and lateral portions of the inner whorls have not been preserved, so that the nature of the tuberculation, if present, cannot be stated.

Measurements. (approximate)

168 mm.	34.5%	33%	30%

In the Malone area the species is limited to the lower division of the Malone formation, in which it is rare. Plesiotype (M. C. Z. 3872) from Rust Hill, southeastern end of the Malone Mountains.

Subfamily SIMOCERATINAE Spath

Genus Neobrites Burckhardt

Neobrites nodocostatus Burckhardt

Plate IX, fig. 1

Neobrites nodocostatus Burckhardt, Bol. del Inst. Geol. de México, No. 29, 1912, pp. 98–99, Pl. XXIII, figs. 1–5.

This species is represented in the writer's collection only by large whorl-fragments showing no deviation in form, ornamentation, and suture-pattern from the Mexican species, as defined by Burckhardt.

The largest whorl at hand has a height of 68 mm. and a breadth of 71 mm. Prominent costae, becoming more inflated and tubercle-like with increase in size, rise at the planispiral suture and traverse the flanks inclined slightly forward, disappearing at the angulations which mark the edges of the smooth, gently-arched venter.

The inner whorls tend to be more compressed. They are traversed laterally by well defined costae which branch above the midpoints of the flanks. The Malone specimens are too fragmentary to disclose the nature of this branching and the disposition of secondary costae on the ventral region.

The entire suture pattern cannot be observed on any single specimen at hand, but the various elements pieced together from several fragments appear to agree with Burckhardt's tracings.

In Mexico the species is restricted to the Kimmeridgian. The holotype is from San Pedro del Gallo. In the Malone Mountains *Neobrites nodocostatus* is restricted to the lower division of the Malone formation. Plesiotype (M. C. Z. 3873) as collected at Ammonite Canyon.

Neobrites cf. nodocostatus Burckhardt

Plate IX, fig. 3

Neobrites nodocostatus Burckhardt, Bol. del Inst. Geol. de México, 1912, No. 29, pp. 98–99, Pl. XXIII, figs. 1–5.

A single whorl-fragment with a height of 40 mm. and breadth of 54 mm. bearing the strong lateral ribbing characteristic of *Neobrites nodocostatus* appears to differ from that species in its broader and flatter ventral area. Sutures are lacking, and the discrepancy noted may be a result of weathering. The fragment (M. C. Z. 3874) was collected from the lower division of the Malone formation at Apple Pass in the Malone Mountains.

Family COSMOCERATIDAE Zittel

Genus Hoplites Neumayr

Subgenus Neocomites Uhlig

Neocomites cf. indicus Uhlig

Plate IV, fig. 1; Plate IX, fig. 2

Neocomites indicus Uhlig, Mem. Geol. Survey India, Palaeontologia Indica, Ser. XV, **4**, Fasc. 2, 1910, pp. 262–263, Pl. LXXXIX, figs. 4a–c.

Included in the writer's collection from the basal sandstone and conglomerate of the Torcer formation is a fragmentary whorl, the

form and ornamentation of which ally it with the group of *Neocomites theodorii*, more specifically with *N. indicus* Uhlig, a Valanginian species from India.

The whorl-section is compressed, with sharpened venter and feebly convex sides merging imperceptibly with the rounded margin of the umbilical wall, which becomes steepened almost to the vertical at the planispiral suture.

Arising at the umbilical suture are conspicuous, closely spaced, sharp costae, which are inflected backward along the umbilical wall, but bend forward at the upper limit of the wall, traversing the flanks in the form of shallow, posteriorly-convex arches. Although the disposition of the lateral costae cannot be completely observed in our specimen, many of the ribs may be observed to divide about the midpoint of the flanks into feebly divergent branches inflected strongly forward in the ventral region, where opposed costations meet in obtuse angles. Other costae remain simple, but whether or not there is systematic alternation of simple and branched ribs is not known. The ribbing appears to be continuous across the venter.

The suture pattern cannot be observed in our specimen. The whorl-section has a height of 31 mm. and a width of 17 mm.

From the type figures of *Neocomites indicus* the Malone form differs in more compressed whorl-section, more closely-spaced costae, and, from some of Uhlig's specimens, by the absence of a ventral furrow. The Indian form, however, appears to be highly variable, and the differences noted are probably not specific.

In density of costation our specimen recalls Burckhardt's *N. densistriatus*, which, however, has a comparatively broad smooth band on the rounded venter. (See Burckhardt, 1912, p. 191, Pl. XLV, figs. 1–3.)

SUMMARY

The results of the writer's study of the ammonites of the Malone area are briefly summarized in the following paragraphs.

The form previously designated by Cragin as *Oppelia* (?) *fallax* Castillo and Aguilera was found to differ significantly from the Mexican species. It appears, moreover, that the Malone form is better classified with *Haploceras* than with *Oppelia*, a suggestion originally made by Spath (Kitchin, 1926, pp. 457–458). Accordingly, the Malone form has been assigned to a new species of *Haploceras* named for Dr. Cragin.

Haploceras cragini exhibits more variation in whorl-section and

umbilication than any other Malone species. Included in the writer's collection are forms constituting a gradational series from relatively robust to markedly compressed forms, all of which possess essentially the same suture patterns and external markings. The species is confined to the lower division of the Malone formation.

The writer has followed Burckhardt's suggestion in referring the species designated by Cragin as *Perisphinctes schucherti* and *P. clarki* to the genus *Idoceras*. Both forms are closely related to Kimmeridgian species described by Burckhardt from San Pedro del Gallo.

The forms previously designated as *Oleostephanus malonianus* Cragin, *Perisphinctes potosinus* Castillo and Aguilera, and *P. felixi* Castillo and Aguilera have been found to represent successive stages in development of a single species of *Lithacoceras*, here designated as *L. malonianum* (Cragin). Previously, Spath had recognized that "*Oleostephanus*" *malonianus* should be reassigned to *Lithacoceras* (Kitchin, 1926, pp. 457–458). *L. malonianum*, which is restricted to the lower division of the Malone formation, is closely related to, if not actually identical with the Kimmeridgian species designated by Burckhardt (1906, pp. 24–25) as *Perisphinctes melachlani*.

The species designated by Cragin as *Perisphinctes aguilerai* is confined to the upper division of the Malone formation. As Uhlig has noted (1907, p. 286), this form belongs to the group of *P. richteri*, "a widely distributed east-Indian and European group of Tithonian age." This group had been previously assigned to the genus *Kossmatia* by Uhlig (1903). The writer has discovered no features in his specimens to prohibit assignment of the Malone species to Uhlig's genus.

Associated with *Kossmatia aguilerai* (Cragin) is *K. zacatecana* Burckhardt, which has not been previously reported from the Malone area. *K. zacatecana* is characteristic of the upper Portlandian (Tithonian) of Mazapil (Burckhardt, 1912, pp. 136–138).

Of particular stratigraphical importance was the discovery of two forms previously described from the Kimmeridgian of San Pedro sel Gallo. These are *Aspidoceras laevigatum* Burckhardt and *Neobrites nodocostatus* Burckhardt, both locally restricted to the lower division of the Malone formation.

Ammonites are rare in the Torcer formation, and where found were confined to the basal sandstone and conglomerate. Most of the specimens are too fragmentary and ill-preserved for even generic identification. A single specimen of *Neocomites* cf. *indicus* Uhlig was, however, collected near V Canyon. The Indian species is from the Valanginian Cretaceous. Species of *Neocomites* have been described

from the Berriasian (infra-Valanginian) of Mexico by Burckhardt (1912, p. 227). The stratigraphical evidence supplied by *Neocomites*, it should be noted, is in accordance with that of the associated foraminifera.

In addition to the species noted above, three new species of *Physodoceras* and one of *Lithacoceras* were discovered in the lower division of the Malone formation.

BIBLIOGRAPHY

Adkins, W. S.
1932. The Mesozoic systems in Texas, in Sellards, E. H., Adkins, W. S., and Plummer, F. B.; The Geology of Texas, **1**, Stratigraphy: Texas Univ. Bull. 3232, pp. 240–518.

Baker, C. L.
1927. Exploratory geology of a part of southwestern Trans-Pecos Texas: Texas Univ. Bull. 2745.

Burckhardt, Carlos.
1906. La faune jurassique de Mazapil: Inst. Geol. México, Bol. 23.

1912. Faunes jurassiques et crétaciques de San Pedro del Gallo: Inst. Geol. México Bol. 29

1930. Etude synthétique sur le Mesozoique mexicain: Schweizer. Palaeont. Gesell. Abh., Vols. 49–50, 1930–1931.

Castillo, Antonio and Aguilera, J. G.
1895. Fauna fósil de la Sierra de Catorce: Comm. Geol. México, Bol. 1.

Cragin, F. W.
1905. Paleontology of the Malone Jurassic formation of Texas: U. S. Geol. Survey Bull. 266, pp. 1–23, pp. 33 *et. seq.*

Favre, E.
1875. Description des fossiles du terrain jurassique de la montagne des Voirons (Savoie): Schweizer. Palaeont. Gesell. Abh., **1**.

Kitchin, F. L.
1926. The so-called Malone Jurassic formation in Texas: Geol. Mag., **63**, pp. 454–469.

Oppel, A.
1863. Ueber jurassische Cephalopoden: Palaeontologische Mittheilungen aus dem Museum des königl. bayerischen Staates, **1**, no. 3.

QUENSTEDT, F. A.

1888. Die Ammoniten des Schwäbischen Jura, III, Der weisse Jura.

UHLIG, VICTOR.

1903. Himalayan fossils; the fauna of the Spiti shales. Geol. Surv. India, Mem. (Palaeontologia Indica), Ser. XV, **4**, Fasc. 1.

1907. Review of Cragin, F. W., Paleontology of the Malone Jurassic formation of Texas: Neues Jahrbuch, 1907, **1**, pp. 285–286.

1910. Himalayan fossils; the fauna of the Spiti shales: Geol. Surv. India, Mem. (Palaeontologia Indica), Ser. XV, **4**, Fasc. 2.

ZITTEL, K. A.

1870. Die Fauna der ältern cephalopodenfuehrenden Tithonbildung: Palaeontographica, Suppl. II.

EXPLANATION OF PLATES

PLATE 1

PLATE 1

Fig. 1. *Physodoceras smithi* Albritton, from lower division of Malone formation at Ammonite Canyon; holotype (M. C. Z. 3869), x ½.

Fig. 2. *Lithacoceras malonianum* (Cragin), from lower division of Malone formation at Ammonite Canyon; whorl-fragment showing disposition of bifurcating and trifurcating costae along lateral and subventral areas; plesiotype (M. C. Z. 3866), x ½.

Figs. 3, 4. *Haploceras cragini* Albritton, from lower division of Malone formation at Ammonite Canyon 3, holotype (M. C. Z. 3861) illustrating relatively compressed variety; 4, paratype (M. C. Z. 3862) illustrating relatively depressed variety; both x ½.

1
2
3
4

PLATE 2

PLATE 2

Fig. 1. *Idoceras schucherti* (Cragin), from lower division of Malone formation at Ammonite Canyon; plesiotype (M. C. Z. 3863), x ¾.

Fig. 2. *Lithacoceras malonianum* (Cragin), from lower division of Malone formation at Ammonite Canyon; plesiotype (M. C. Z. 3865), x ½.

1

2

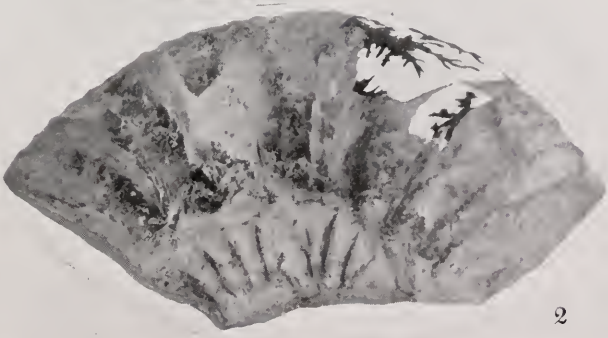
PLATE 3

PLATE 3

Fig. 1. *Idoceras clarki* (Cragin), from lower division of Malone formation at Ammonite Canyon; plesiotype (M. C. Z. 3864), x ½.

Fig. 2. *Lithacoceras shuleri* Albritton, from lower division of Malone formation at Ammonite Canyon; holotype (M. C. Z. 3867), x ¾.

1



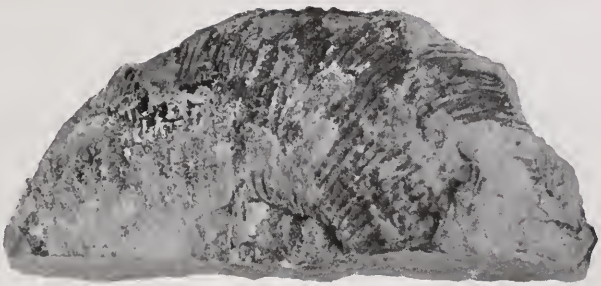
2

PLATE 4

PLATE 4

Fig. 1. *Neocomites* cf. *indicus* Uhlig, from basal conglomerate and sandstone of Torcer formation at V Canyon; plesiotype (M. C. Z. 3878), x ¾.

Fig. 2. *Physodoceras booni* Albritton, from lower division of Malone formation at Ammonite Canyon; holotype (M. C. Z. 3871), x 4/5.



1

2

PLATE 5

PLATE 5

Figs. 1–4. *Haploceras cragini* Albritton, 1—Whorl-section of relatively depressed form; 4—Whorl-section of relatively compressed form; 2–3—Suture lines.

Figs. 5, 8, 9. *Idoceras clarki* (Cragin). 5—A nearly complete suture line; 8—Details of the broad siphonal lobe; 9—Whorl-section.

Figs. 6, 7. *Idoceras schucherti* (Cragin). Suture line and whorl-section.

(All figures x ¾)

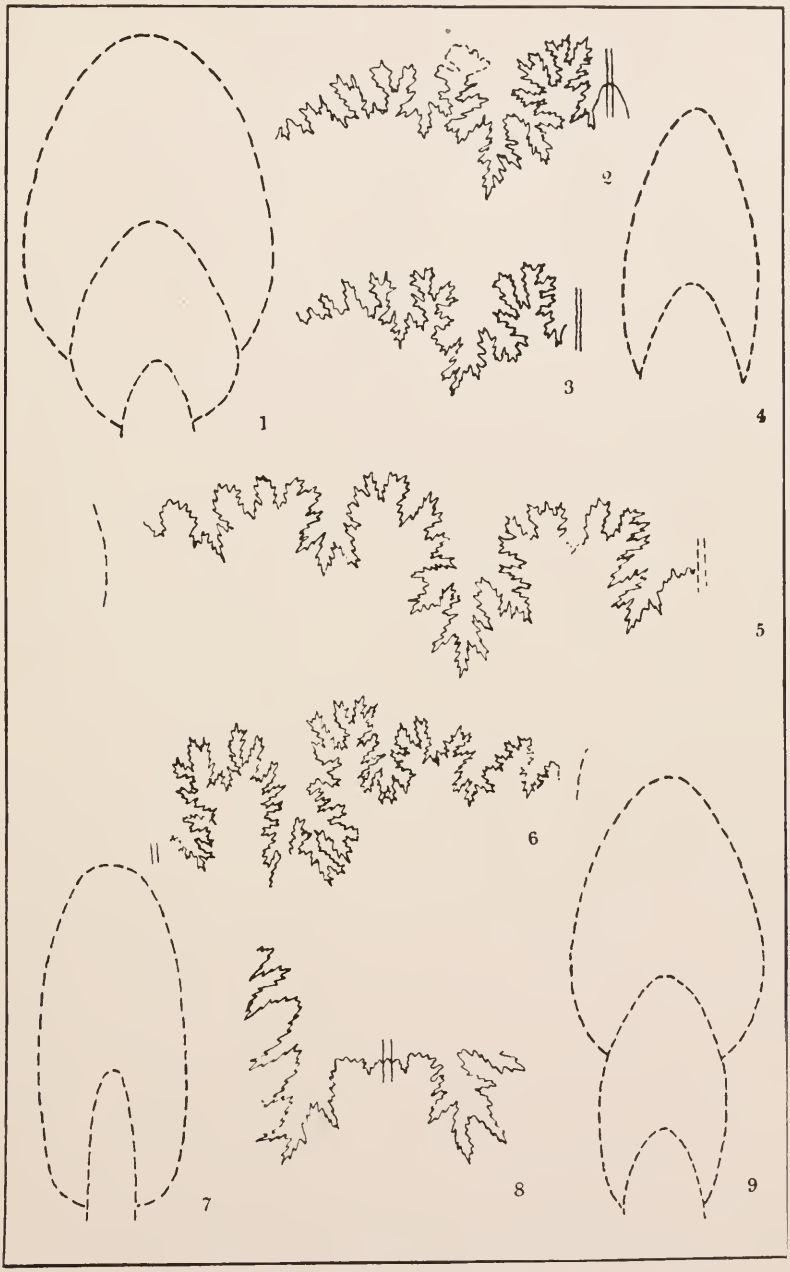

1
2
3
4
5
6
7
8
9

PLATE 6

PLATE 6

Figs. 1–3. *Lithacoceras malonianum* (Cragin). Whorl-sections and tracing of suture line.

(All figures x ¾)

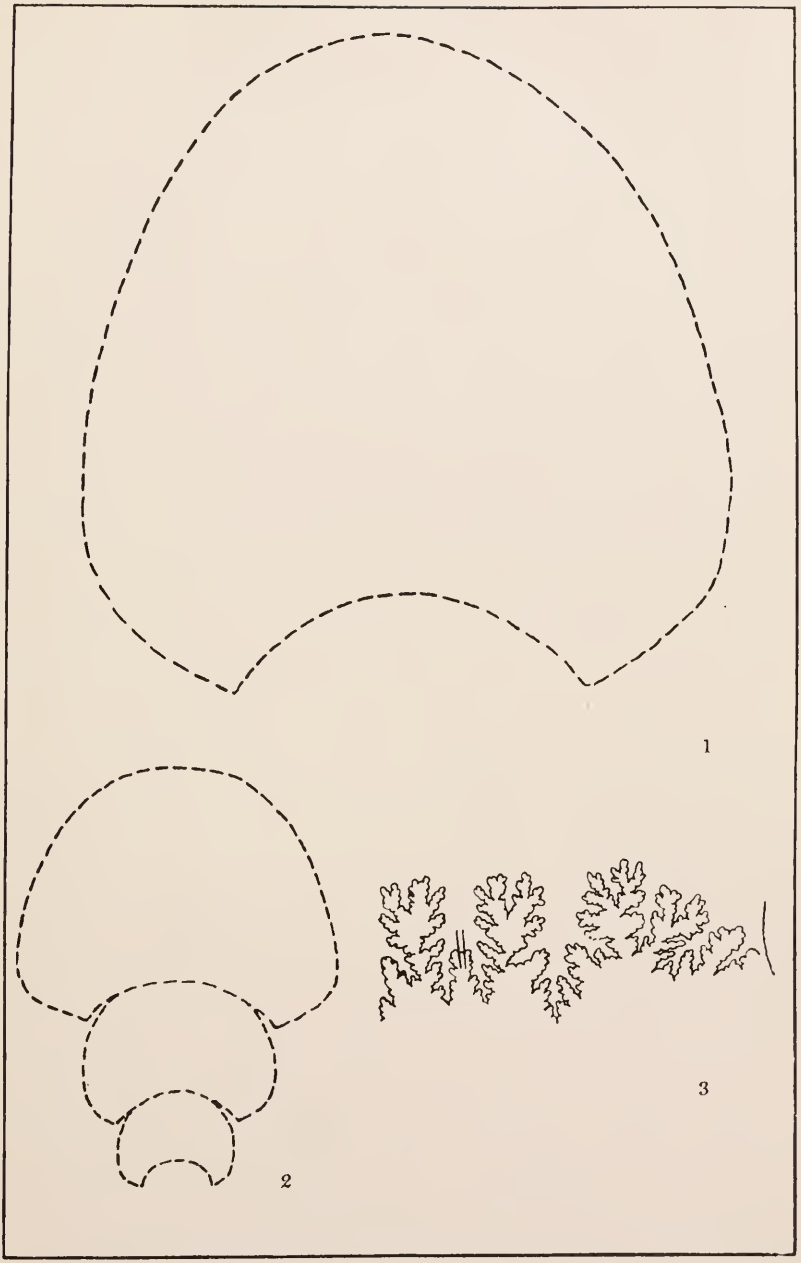

1
2
3

PLATE 7

PLATE 7

Figs. 1, 2, 4. *Lithacoceras shuleri* Albritton, 1—Section of one of the larger whorls; tubercles indicated by shaded area; 2, 4—Tracints of imperfect suture lines.

Fig. 3. *Kossmatia zacatecana* Burckhardt. Section of one of the smaller whorls.

(All figures x ¾)

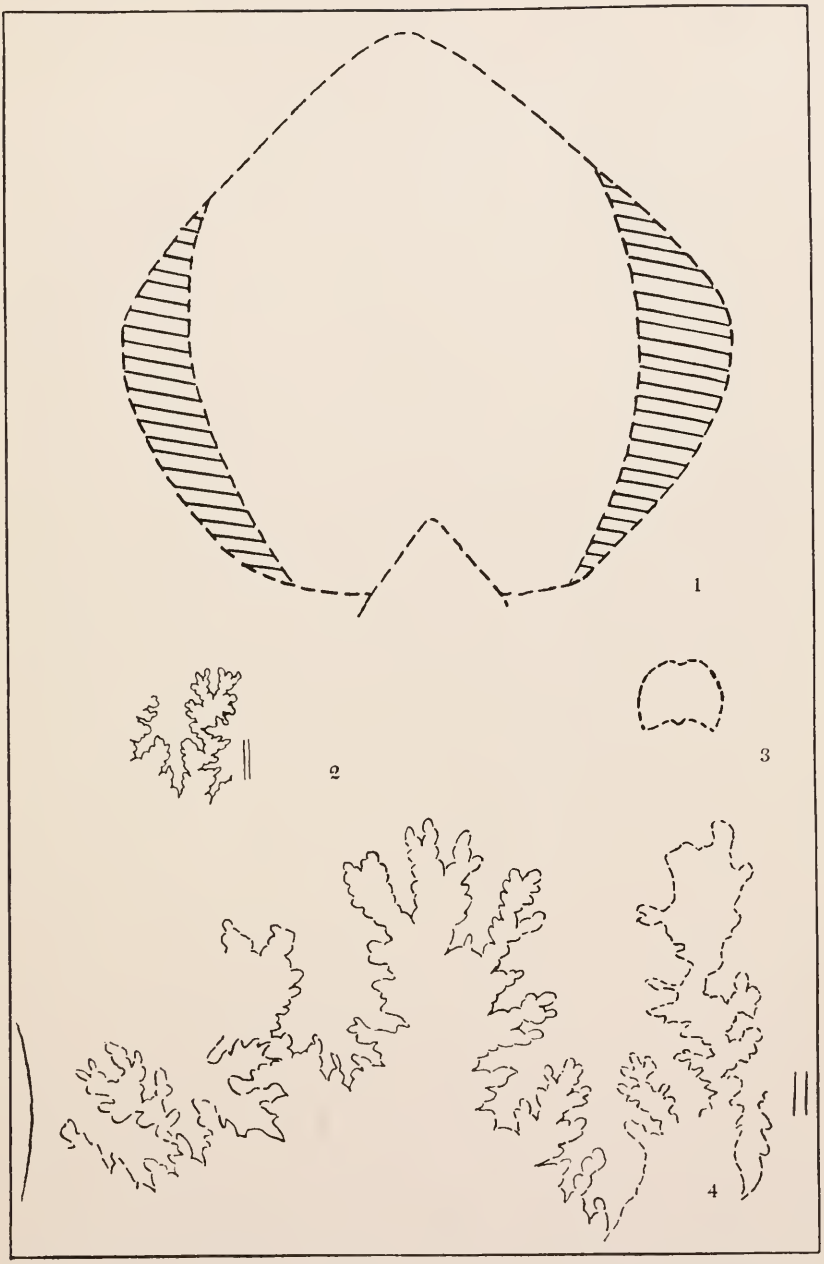

1
2
3
4

PLATE 8

PLATE 8

Figs. 1, 3. *Physodoceras smithi* Albritton. Whorl-sections and tracing of imperfect suture line.

Figs. 2, 6. *Kossmatia aguilerai* (Cragin). Whorl-sections.

Fig. 4. *Physodoceras bakeri* Albritton. Whorl-section.

Fig. 5. *Aspidoceras* cf. *laevigatum* Burckhardt. Whorl-section.

(All figures x ¾)

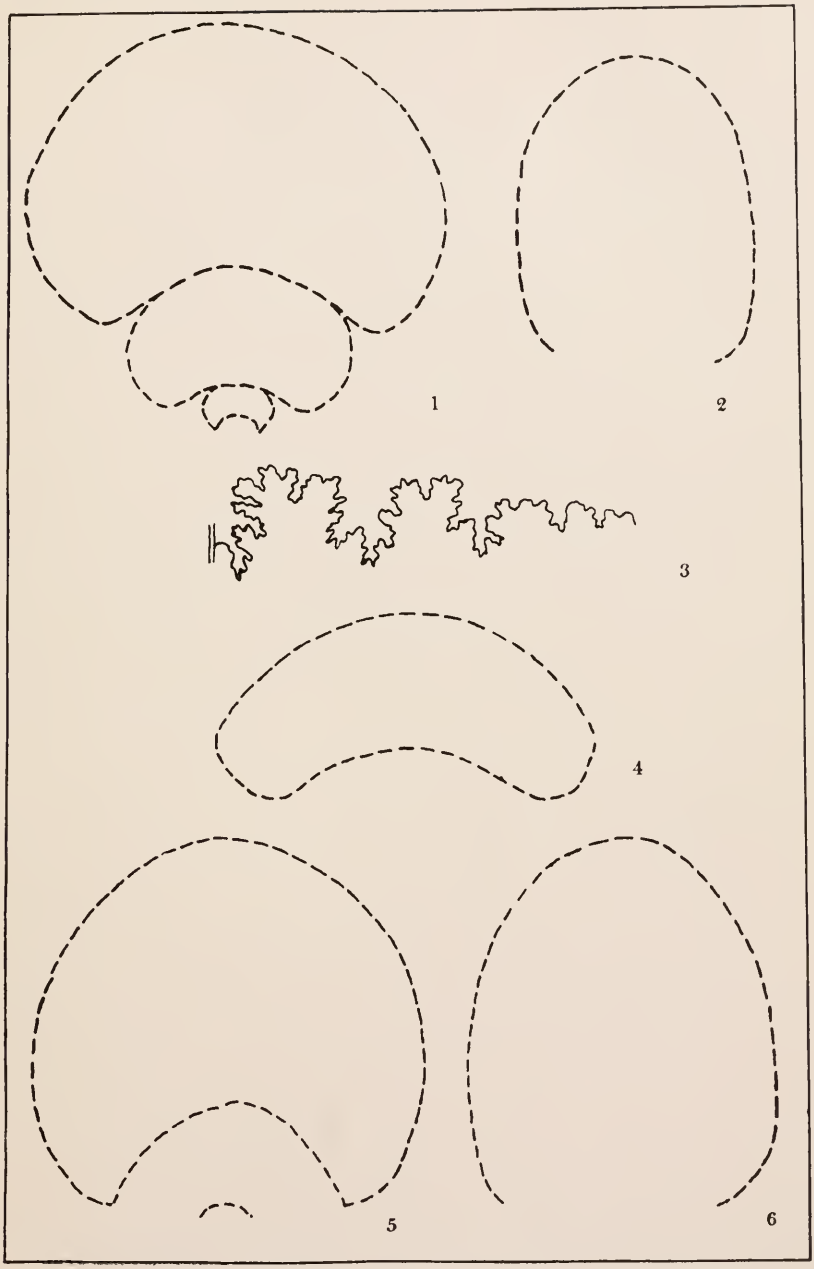

1
2
3
4
5
6

PLATE 9

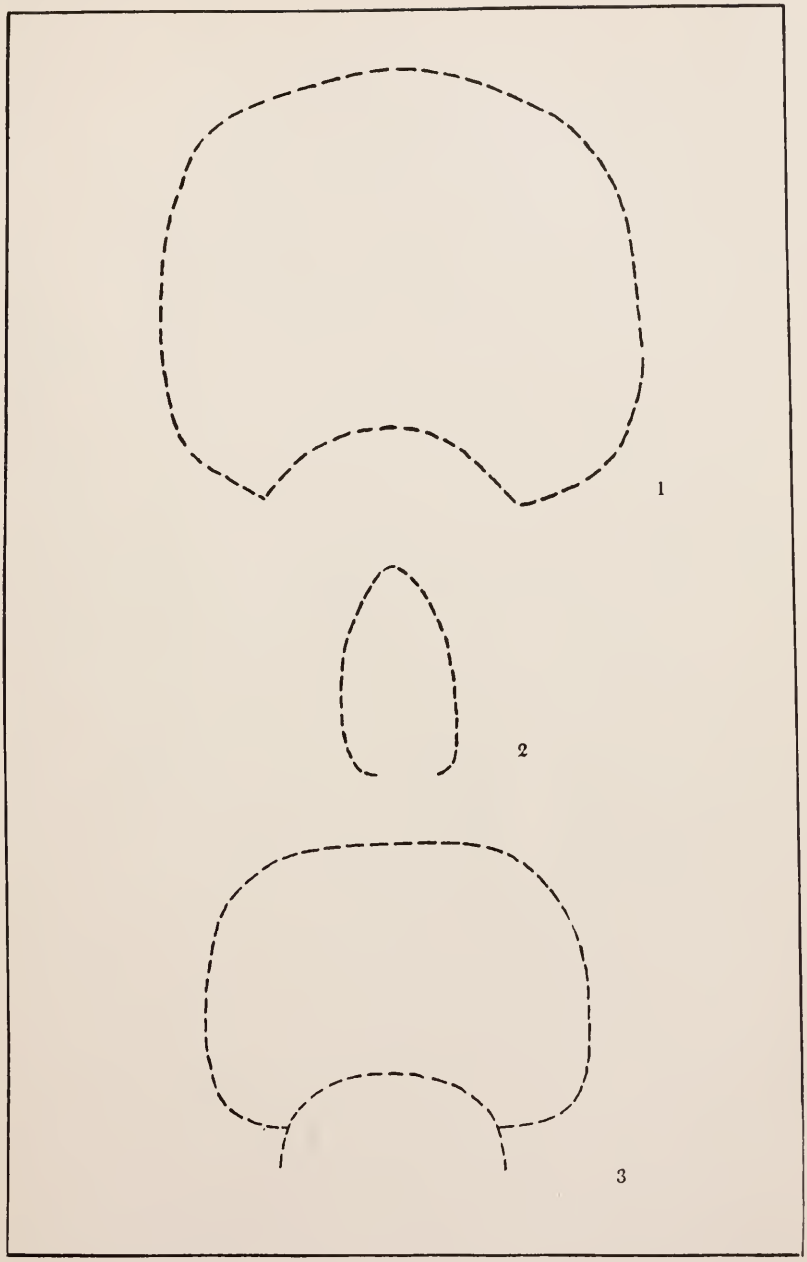
PLATE 9

Fig. 1. *Neobrites nodocostatus* Burckhardt. Whorl-section.

Fig. 2. *Neocomites* cf. *indicus* Uhlig. Whorl-section.

Fig. 3. *Neobrites* cf. *nodocostatus* Burckhardt. Whorl-section.

(All figures x ¾)


1
2
3

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
VOL. LXXX, No. 11

NEW LICHADACEA IN THE COLLECTIONS OF THE MUSEUM OF COMPARATIVE ZOÖLOGY

BY FRED B. PHLEGER, JR.

WITH TWO PLATES

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
OCTOBER, 1937

No. 11. — *New Lichadacea in the Collections of the Museum of Comparative Zoölogy*

By Fred B. Phleger, Jr.

This paper is based upon specimens of lichadian trilobites in the collections of the Museum of Comparative Zoölogy. In the course of a comprehensive study of the genera of this group, the writer had previously observed a few new species in this collection. These are here described, and some old species are redescribed in the light of specimens at hand. Illustrations of plesiotype specimens are included only when they add to, or correct, those already published.

The writer is grateful to Professor P. E. Raymond for his criticism.

Phylum	ARTHROPODA
Class	CRUSTACEA
Subclass	TRILOBITA
Order	OPISTHOPARIA Beecher
Superfamily	LICHADACEA Phleger
Family	LICHADIDAE Hawle and Corda
Subfamily	LICHADINAE Gürich
Genus	ARCTINURUS Castelnau

Arctinurus boltoni (Bigsby)

Plate **2**, fig. 1

Paradoxides boltoni, Bigsby, Journ. Acad. Nat. Sci. Philadelphia, 1st. ser., **4**, pt. 2, 1825, p. 365, pl. 23.

Arctinurus boltoni, Castelnau, Essai Syst. Silur. l'Amer., 1843., p. 21, pl. 3.

Lichas boltoni, Hall, Pal. New York, **2**, 1852, p. 311, pl. 69; pl. 70, figs. la-g, j-l.

Lichas (*Oncholichas*) *boltoni*, Schmidt, Mem. l'Acad. Imp. Sci. St. Petersburg, 7th. ser., **33**, 1885, p. 31.

Pterolichas boltoni, Gürich, Neues Jarb. f. Min., Geol., u Pal., Beilag, **14**, 1901, p. 528, pl. 20, fig. 2.

For complete synonomy see Bassler, U. S. Nat. Mus. Bull. 92.

Inasmuch as there is no concise and completely accurate description of this species available, it seems advisable to re-describe it in the light of the most recent interpretations of the morphology of the Lichadacea. The following description is based upon a complete

specimen which has been generously loaned by Dr. Rudolph Ruedemann from the New York State Museum. Photographs of it are in the Museum of Comparative Zoölogy, where there are also several incomplete specimens, mostly pygidia.

Cephalon large, much wider than long, with wide free cheeks. There is a raised area, the borders of which correspond in position to the axial furrows on the thorax, and on which are the glabella and a part of the fixed cheeks. The eyes are large, elongate, close to the glabella; they extend from a little in front of the occipital furrow to a position parallel to the second lateral glabellar furrows. The facial sutures cut the posterior margin of the cephalon about halfway between the genal angle and the axial furrows on the occipital lobe, traverse the cephalon at a low angle to the posterior tips of the eyes; anterior to the eyes their course cannot be determined. The fixed cheeks are small and narrow. The glabella is comparatively long and narrow, produced in a tongue-like projection. The median glabellar lobe is narrow in the middle part of its extent but flares anteriorly; it also flares slightly posteriorly. The longitudinal glabellar furrows are complete and extend to the occipital furrow; they are weakly incised from the position of the third lateral furrows to the occipital furrow. The anterior lateral furrows are complete; the second and third are indicated by notches on the longitudinal furrows; the fourth laterals apparently are not represented.

The thorax is wider than long, composed of eleven segments. The pleural lobes are slightly wider than the median, each pleuron produced into a free point. Each is traversed by a diagonal furrow.

The pygidium is composed of three pairs of wide lateral segments, each ending in a free point and traversed by a diagonal furrow. The axial lobe has two furrows; it rapidly narrows, only the anterior one-third is elevated; from there it flares posteriorly.

The surface of the specimen is covered with coarse pustules with the exception of a fairly wide and continuous border on which there are none, but which is ornamented with parallel and more or less continuous furrows.

Formation and locality: Lockport shale, Rochester, New York.

Arctinurus pugnax (Winchell and Marcy)

Lichas pugnax Winchell and Marcy, Mem. Boston Soc. Nat. Hist., 1866, **1**, pt. 1, p. 103, pl. 3, fig. 10.; Hall, 20th. Rept. New York State Cab. Nat. Hist., 1867, p. 393 (revised edition, p. 424, pl. 25, fig. 20.).

There is an excellent specimen of a glabella belonging to this species in the collection. Unfortunately, the palpebral lobes are not preserved, so that it is not possible to ascertain the size and position of the eyes. The frontal brim, which is broken, may or may not have had the tongue-shaped projection which is characteristic of *Arctinurus*. In other respects, however, the specimen at hand agrees closely with that genus.

A. pugnax differs from *A. boltoni* (Bigsby)[1] in having the glabellar lobes more inflated and set off from each other, and in having the anterior part of the median lobe produced dorsally in a mound-shaped projection.

Formation and locality: Racine (Silurian), Cicero, Illinois.

Day collection. From W. C. Egan.

The plesiotype is Mus. Comp. Zoöl. no. 1552.

Subfamily HOMOLICHADINAE Phleger

Genus TRIMEROLICHAS Phleger

TRIMEROLICHAS MARGINATUS (Lindström)

Lichas marginatus Lindström, Ofversigt af. Kongl. Vet.-Akad. Forhandlingar, 1885, p. 58, pl. 14, figs. 8, 9.

There is a specimen of this species in the collection which shows some interesting new features. The wide brim around the anterior part of the cephalon is well-developed and strongly turned upward. The comparatively small eye is located between the position of the second and third lateral furrows, close to the glabella. The median glabellar lobe is very narrow for a part of its extension between the lateral lobes, and flares only slightly posteriorly. The positions of the second lateral furrows are clearly indicated by notches on the longitudinal furrows. The basal lobes are small, elongate, and tapered at the ends; they are distinctly offset outside the posterior ends of the lateral lobes.

Formation and locality: Dudley formation, Dudley, England.

The plesiotype is Mus. Comp. Zoöl. no. 1553.

TRIMEROLOCHAS BREVICEPS (Hall)

Lichas breviceps Hall, Trans. Albany Inst., 1863, **4**, p. 233; 28th. Rept. New York State Mus. Nat. Hist., 1879, p. 197, pl. 34, figs. 1–7.

[1] See illustration in this paper, pl. 2, fig. 1.

There are three specimens of this species in the collection. Since Hall's description was not quite complete, a few additions to it are here appended.

The glabellae are only moderately convex. There is a distinct brim on the anterior part of the cephalon. The third glabellar furrows, although not present on the lateral lobes, are represented on the median glabellar lobe. The basal lobes are very small and elongate, and are offset outside the tricomposite lobes.

Formation and locality: Waldron shale, Indiana.

The plesiotypes are Mus. Comp. Zoöl. no. 4472.

Trimerolichas trentonensis (Hall)

Platynotus trentonensis Hall, Pal. New York, **1**, 1847, p. 235, pl. 64, figs. 1a-d.
Platymetopus trentonensis, Weller, 1903, Geol. Surv. New Jersey, Pal., **3**, p. 200, pl. 15, figs. 17–19.

This species was placed in *Platynotus* by Hall and *Platymetopus* by Weller. Both these names are now partially the equivalent of *Tetralichas*. Hall's species does not have the quadricomposite lobes which are characteristic of *Tetralichas*, and clearly belongs to *Trimerolichas*.

Trimerolichas trentonensis (Hall) should not be confused with *Tetralichas trentonensis* (Conrad).

The plesiotype is Mus. Comp. Zoöl. no. 4471.

Trimerolichas obvius (Hall)

Lichas obvius Hall, 20th. Rept. New York State Cab. Nat. Hist., rev. ed., 1870, p. 424, pl. 25, fig. 19.

Hall's description of this species is incomplete. The illustration clearly shows comparatively large basal lobes, and the longitudinal furrows abruptly diverge from the median lobe at the position of the third lateral glabellar furrows. This species undoubtedly belongs in *Trimerolichas*.

Trimerolichas warburgae spec. nov.

Plate **1**, fig. 7

The glabella is as wide as long, moderately inflated. The tricomposite lateral lobes are broadly rounded anteriorly and pointed

posteriorly. The inside margin of the basal lobes begin just mesially from the posterior pointed termination of the tricomposite lobes and are extended outward therefrom; they are egg-shaped, with the pointed end inward. The middle glabellar lobe flares forward from the position of the third lateral furrows. The third lateral furrows are indicated by abrupt outward deflections of the posterior parts of the longitudinal furrows.

Measurements

Length of glabella	11 mm.
Width of glabella	11 mm.
Width of lateral lobes	3.5 mm.
Width of median lobe in most narrow part	4 mm.

This species differs from *Trimerolichas trentonensis* (Hall)[1], to which it is most closely allied, in having larger basal lobes and in having the posterior course of the longitudinal furrows abruptly deflected outward. Moreover, in *T. trentonensis* the longitudinal furrows are almost parallel in the middle part of their course, whereas, they are converging in *T. warburgae.*

Formation and locality: Cincinnatian, Cincinnati, Ohio.

The holotype is Mus. Comp. Zoöl. no. 4473.

Trimerolichas inexpectans spec. nov.

Plate **1**, fig. 4

The glabella is inflated, almost as long as wide. The lateral glabellar lobes are completely circumscribed; the second lateral furrows are indicated by notches on the longitudinal furrows. The basal glabellar lobes are very small, elongate, and offset outside the posterior terminations of the lateral lobes. The occipital segment is very wide.

Length of glabella	17 mm.
Width of glabella	16 mm.
Width of lateral lobe	5 mm.
Width of median lobe at most narrow part	3 mm.

This species is closely related to *Trimerolichas obvius* (Hall), but differs from it in having smaller basal glabellar lobes, in having the second lateral glabellar furrows indicated by notches on the longitudinal furrows, and in having the posterior extension of the longitudi-

[1] Hall, Pal. New York, **1**, 1847, p. 235, pl. 64, figs. 1a-d.

nal furrows more broadly rounded in outline, and apparently in having a wider occipital segment. *T. inexpectans* differs from *T. warburgae* in having smaller basal glabellar lobes, and in having the median glabellar lobe more constricted between the lateral ones.

In neither *T. inexpectans* nor *T. obvius* is the wide anterior brim characteristic of the genus *Trimerolichas* preserved. It is presumed that the brim has been destroyed, since the specimens are incompletely preserved. If this feature does not actually exist, however, the two species probably belong to a new genus.

Formation and locality: Wauwatosa (Silurian), Wauwatosa, Wisconsin.

The holotype is Mus. Comp. Zoöl. no. 1551.

Family TROCHURIDAE Phleger

Subfamily TROCHURINAE Phleger

Genus Trochurus Beyrich

Trochurus bulbosus spec. nov.

Plate 1, figs. 5, 6

The cranidium is small, strongly convex, with the anterior glabellar lobe overhanging the frontal margin. There is a row of small spines projecting from the frontal border. The surface is covered with small and uniform pustules.

Length 6mm., width 7.5mm.

Trochurus bulbosus differs from *T. phlyctainoides* (Green), (as figured by Hall and Weller)[1], to which it is closely allied, in having glabellar furrows which are more deeply incised, and in having a constriction of the median lobe between the third lateral lobes. It differs from all other species of *Trochurus* in having spines projecting from the frontal border.

Formation and locality: Clinton drift at Trenton Falls, New York.

Collected by C. D. Walcott.

The holotype is Mus. Comp. Zoöl. no. 1555.

[1] Hall, Pal. New York, **2**, 1852, p. 314, pl. 70, figs. 2a-c; Weller, Bull. Chicago Acad. Sci., Nat. Hist. Surv., **4**, pt. 2, 1907, p. 234, pl. 22, figs. 1–4.

Genus Raymondarges gen. nov.

Trochurinae with longitudinal furrows incomplete or faintly incised posterior to the third lateral furrows; third lateral furrows incomplete or faintly incised; fourth lateral furrows absent. *Raymondarges* differs in these respects from *Trochurus*.

This genus represents a specialized end stage of one branch of the Trochurinae. Although the glabellar lobation is weakly developed, there are indications of the former presence of the typical trochurid lobation. *Raymondarges* undoubtedly descended from *Trochurus* in Lower or Middle Silurian times.

Genotype: *Raymondarges reporyjensis* Phleger.

Raymondarges reporyjensis spec. nov.

Plate 1, figs. 8, 9

The glabella is inflated and has a narrow anterior brim. There are fairly deep pits at the junction of the longitudinal and third lateral furrows; a slight depression extends across the median lobe at the position of the third lateral furrows. The median lobe at its most narrow part is about 50% wider than either lateral lobe. The lateral lobes are defined on the outside by well-incised and complete axial furrows. In some specimens there is a faint depression marking the extension of the longitudinal furrows to the occipital furrow. In one the fourth lateral furrows are very faintly indicated mesally; this clearly shows that the basal lobes have united with the third lateral lobes and are fundamentally a part of the lateral glabellar lobation.

Measurements

Length of glabella	9.5 mm.
Width of glabella	7 mm.
Width of lateral lobe	2 mm.
Width of median lobe in most narrow part	3 mm.

Formation and locality: Etage E-e2, Reporyje, Bohemia.

The holotype is Mus. Comp. Zool. no. 4476.

Subfamily EUARGINAE Gürich

Genus Euerges Gürich

Euarges branikensis (Barrande)

Plate 1, fig. 3

Lichas branikensis Barrande, Syst. Silur. de la Bohême, **1**, suppl., 1872, p. 43, pl. 16, figs. 31–33.

Barrande apparently knew only the hypostoma and pygidium of this species. In this collection there are several cranidia from Branik, Bohemia.

The cranidium is similar to that of *Euarges parvulus* (Novak), the principal difference being that the median lobe is not parallel-sided, but expands rapidly forward, anterior to the bicomposite lateral lobes, so that it occupies the entire width of the glabella at the frontal margin.

Length of cranidium	2.5 mm.
Width of the cranidium	3.5 mm.

The plesiotype is Mus. Comp. Zoöl. no. 4474.

Subfamily DICRANOPELTINAE Phleger

Genus Dicranopeltis Hawle and Corda

Dicranopeltis fragosa spec. nov.

Plate 1, fig. 2

The cranidium is almost semicircular, flattened, and covered with pustules of irregular size. The longitudinal furrows are very weakly incised between the third and fourth lateral glabellar furrows; the second lateral furrows are indicated by notches on the longitudinal furrows. The basal lobes are small, separated from the third lateral lobes by narrow furrows.

Cranidium 18mm. long, 18mm. wide at the palpebral lobes, and 24mm. wide at the base.

Dicranopeltis fragosa closely resembles *D. decipiens* (Winchell and Marcy) as figured by Weller,[1] but differs in showing the notch of the second lateral glabellar furrows on the longitudinal furrows, in having

[1]Weller, Stuart, op. cit., pl. 22, figs. 10, 11.

the glabellar lobes less convex, and in having the longitudinal furrows less clearly incised between the third and fourth lateral furrows.

Formation and locality: Rochester shale, Lockport, New York.

The holotype is Mus. Comp. Zoöl. no. 1556.

Subfamily PLATYLICHADINAE Phleger

Genus AUTOLOXOLICHAS Phleger

AUTOLOXOLICHAS REEDI spec. nov.

Plate 1, fig. 1

The cranidium is inflated, wider than long, with the anterior portion evenly rounded in plan. The completely circumscribed tricomposite lobes are elongate, oval, with a pit marking the position of the second lateral furrows, and with the third lateral glabellar furrows very deeply incised.

Measurements

Length of cranidium	33 mm.
Greatest width of cranidium	42 mm.
Width of lateral lobe	7 mm.
Width of median lobe at most narrow part	8 mm.

Autoloxolichas reedi differs from *A. st. mathiae* (Schmidt)[1], which it closely resembles, in the following respects: the cranidium is more inflated, the third lateral furrows are very deeply incised and are not so close to the occipital furrow, and the lateral glabellar lobes do not expand anteriorly.

This is the oldest platylichad known; it definitely extends the Platylichadinae (Trochuridae) into the Lower Ordovician. For this reason it seems more likely that *Platylichas* is descended from *Autoloxolichas*, instead of *vice versa*, as the writer has previously suggested. It is also further evidence that Europe was the center of dispersal of the Lichadacea, since the three oldest genera of this superfamily are restricted to that continent.

Formation and locality: Etage D-di gamma, Vosek, Bohemia.

The holotype is Mus. Comp. Zoöl. no. 4475.

[1] Schmidt, Fr., op. cit, pp. 115–118, pl. 5, figs. 11–16.

EXPLANATION OF PLATES

PLATE 1

PLATE 1

Fig. 1. *Autoloxolichas reedi* Phleger. Dorsal view of cranidium of the holotype.

Fig. 2. *Dicranopeltis fragosa* Phleger. Dorsal view of cranidium of the holotype.

Fig. 3. *Euarges branikensis* (Barrande). Dorsal view of cranidium of the plesiotype. x3.

Fig. 4. *Trimerolichas inexpectans* Phleger. Dorsal view of cranidium of the holotype.

Fig. 5. *Trochurus bulbosus* Phleger. Anterior view of cranidium of the holotype, showing the spines which are produced from the frontal border. x2.

Fig. 6. *Trochurus bulbosus* Phleger. Dorsal view of cranidium of the holotype. x2.

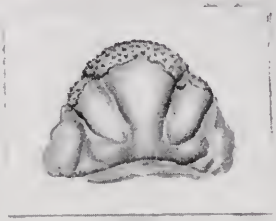
Fig. 7. *Trimerolichas warburgae* Phleger. Dorsal view of cranidium of the holotype.

Fig. 8. *Raymondagres reporyjensis* Phleger. Outline drawing of anterior view of the cranidium of the holotype. x2.

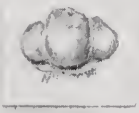
Fig. 9. *Raymondarges reporyjensis* Phleger. Dorsal view of cranidium of the holotype. x2.

All reproductions are natural size, unless otherwise specified.

1

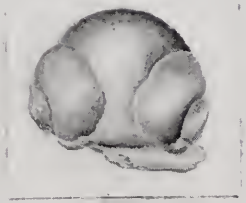


2



5

3



4

6

7

8

9

PLATE 2

PLATE 2

Photograph of a complete specimen of *Arctinurus boltoni* (Bigsby). Natural size.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
VOL. LXXX, No. 12

BIRD REMAINS FROM CAVE DEPOSITS ON GREAT EXUMA ISLAND IN THE BAHAMAS

BY ALEXANDER WETMORE

WITH ONE PLATE

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
OCTOBER, 1937

No. 12.—*Bird Remains from Cave Deposits on Great Exuma Island in the Bahamas*

By Alexander Wetmore

During recent months the Museum of Comparative Zoölogy has received a collection of animal bones from cavern deposits on Great Exuma Island in the Bahama group that contains bird remains of exceptional interest. The specimens in question were sorted out by Mrs. Vivienne Knowles from cave earth excavated for use as fertilizer, and were obtained during the early part of 1937. It is fortunate indeed that Mrs. Knowles has had the foresight to preserve this material since the information secured from the bird bones represents the most important contribution in new information concerning the avifauna of the Bahamas that has come in many years.

In brief, in this small collection there are included three extinct forms, viz., two hawks and a giant owl, that are new to science. There are in addition remains of a crow and of a flicker, both like species living today in Cuba. It is easily evident that the bird life of the Bahaman group in past centuries has contained far more species than in modern times, the present avifauna being a mere remnant of what was found in the past. Explanation of the reduction in kinds of birds in these islands is naturally speculative, but we may suppose with reason that the hurricanes that periodically sweep this area have been one definite factor, possibly the one of greatest importance. It will be recalled that only recently a tremendous storm that crossed the southern tip of Florida and the Florida Keys destroyed the majority of the individuals of the great white heron (*Ardea occidentalis*) now restricted in range to that section. A slightly greater spread of the area of maximum damage, or a longer continuation of the period of greatest violence, might have wiped out the few herons that remained. It is easy to believe that tremendous storms of a similar nature centering on islands in the Bahamas in past years may have completely overwhelmed some of them so as to destroy many elements in the indigenous fauna.

As for the age of these cavern deposits there is much uncertainty. The present collection is without question of the pre-Columbian period.

In previous years I have supposed that similar bird remains from caves in Puerto Rico and Haiti dated back from five hundred to two thousand years. As my studies of this type of material continue I have become more and more convinced that it has a considerable antiquity, and that most of it probably should be given the maximum span of years indicated, with the possibility that it has even greater age.

Preliminary examination of the collection was made by Dr. Glover M. Allen, and subsequently the bones were placed in my hands for study by Dr. Thomas Barbour, Director of the Museum of Comparative Zoölogy. To both of these gentlemen I am indebted for this opportunity. Drawings illustrating the various species have been made by Sydney Prentice.

Family ACCIPITRIDAE

Accipiter striatus velox (Wilson). Sharp-shinned Hawk

Falco velox Wilson, Amer. Orn., 5, 1812, p. 116, pl. 45, fig. 1. (Banks of the Schuylkill River near Philadelphia, Pennsylvania.)

A right humerus (Cat. no. 2255) lacking the head belongs to the sharp-shinned hawk, being the form that nests in northern North America that has been obtained as a migrant on New Providence Island in the Bahamas. The specimen has the dimensions of a female, being decidedly larger than the resident sharp-shinned hawks of the Greater Antilles.

While the sharp-shinned hawk is listed in the fourth edition of the A. O. U. Check-list published in 1931 as *Accipiter velox velox*, since this form is conspecific with the West Indian races, it must bear the specific name *striatus* of Vieillot, this having been published before *velox* of Wilson.

Calohierax gen. nov.

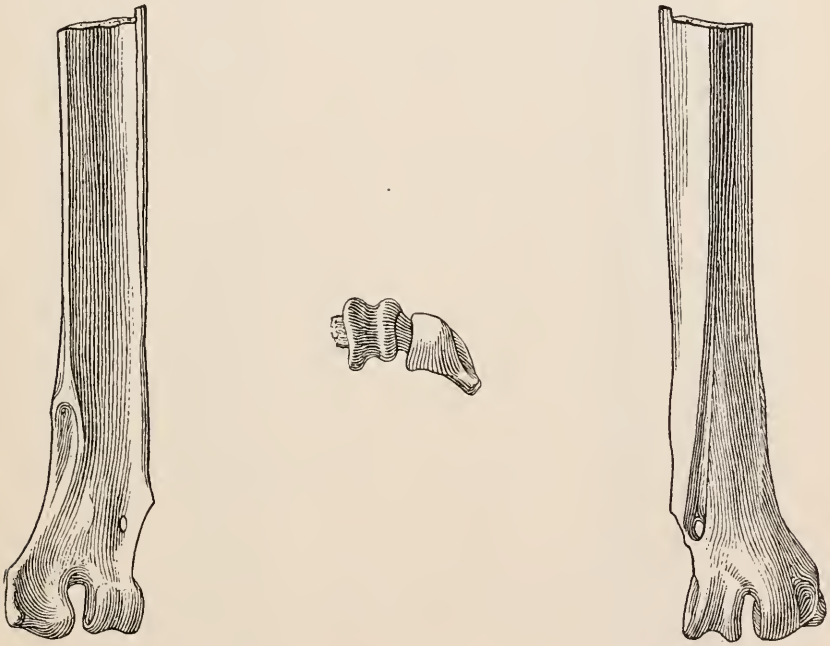
Characters. Distal end of metatarsus similar to that of Buteo[1] but with trochlea reduced in size; second trochlea with projecting wing shortened.

Type, *Calohierax quadratus*, sp. nov.

[1] *Buteo* Lacépède, Tabl. Ois., 1799, p. 4.

Calohierax quadratus sp. nov.

Characters. Distal end of metatarsus (figs. 1–3) similar to that of *Buteo jamaicensis* (Gmelin)[1] but with the projecting outer portion of the second trochlea much reduced so that the trochlea appears square and block-like; middle trochlea smaller.



Figs. 1–3. Metatarsus, type, of *Calohierax quadratus*, including the distal profile of the trochlea. (About twice natural size.)

Description. Type, distal part of right tarso-metatarsus with outer trochlea missing, Museum of Comparative Zoölogy Cat. no. 2256, collected from cave deposits on Great Exuma Island, Bahama Islands, in 1937, by Mrs. Vivienne Knowles.

Lower portion of shaft triangular in outline, with a broad U-shaped depression on its posterior face; outer surface nearly plane, narrowing

[1] *Falco jamaicensis* Gmelin, Syst. Nat., **1**, pt. 1, 1788, p. 266.

gradually toward the trochlea; inner surface slightly concave, broadened below, where it merges gradually into an expanded section that supports the trochlea; a well-marked inferior foramen located at the bottom of a long groove extending down the front of the shaft; outer trochlea missing; middle trochlea relatively small, elliptical in outline, much excavated on its lateral faces, with a deep groove extending clear around its articular surface, separated by a narrow intertrochlear sulcus from the inner trochlea; inner trochlea seen from behind roughly quadrangular, this posterior surface being faintly concave; outer face deeply concave; the projecting outer margin, prominent in related hawks, much shortened and reduced; impression for the articulation of the hallux prominent, located rather low on the shaft. Bone without organic matter, ivory white in color.

Measurements. Smallest transverse diameter of shaft 5.8; transverse diameter of middle trochlea 3.5; of outer trochlea 4.7 mm.

Remarks. The present species, to judge from the distal part of the metatarsus, was slightly smaller than the modern red-tailed hawk, having more or less the dimensions of the red-shouldered hawk (*Buteo lineatus*). While regarded as a member of the subfamily *Buteoninae* it differs from any species of that group known to me in the narrowed form of the outer trochlea; in fact in this it is unlike any of its relatives, this being the principal reason for its description, as ordinarily a specimen of such fragmentary nature would hardly warrant specific identification.

Calohierax quadratus represents a highly peculiar form of a type new to the Bahama Islands, and one apparently not closely related to any of the living hawks of tropical America.

Titanohierax new genus

Characters. Similar to living *Hypomorphnus urubitinga*[1] but much larger; tarso-metatarsus (Figs. 4–7) relatively broader at distal end; middle trochlea relatively longer and larger, projecting farther distally in relation to outer trochlea; facet for articulation of hallux extending relatively higher on shaft; shaft more robust.

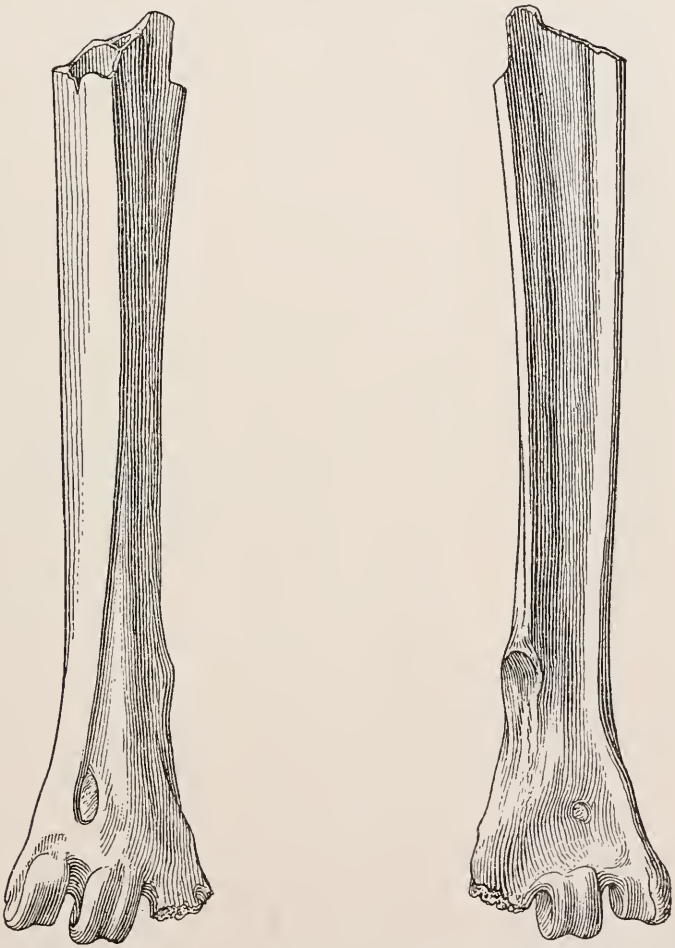
Type, *Titanohierax gloveralleni*, sp. nov.

[1] *Falco Urubitinga* Gmelin, Syst. Nat., **1**, pt. 1, 1788, p. 265.

TITANOHIERAX GLOVERALLENI sp. nov.

Characters. Those of genus as given above.

Description. Type, Museum of Comparative Zoölogy Cat. No.



Figs. 4–5. Two views of metatarsus, type, of *Titanohierax gloveralleni*, natural size.

2257, right tarso-metatarsus with upper part of shaft and greater part of inner trochlea missing, from cave deposits on Great Exuma

Island, Bahama Islands, collected by Mrs. Vivienne Knowles, in 1937.

Outer trochlea narrow, compressed laterally, its outer margin pro-

Figs. 6–7. Two views of metatarsus, type, of *Titanohierax gloveralleni*, natural size.

duced in a thin, posteriorly projecting plate that is about one third the width of the trochlea, making an open angle with the body of the

trochlea; inner face of trochlea somewhat excavated, groove separating it from the middle trochlea relatively shallow and narrow; middle trochlea heavier, a flattened ellipse in outline, its axis forming a slight angle with the axis of the shaft, with its sides excavated, and a pronounced groove extending around the articular surface; wider at base anteriorly than on posterior side; inner trochlea missing except for broad, flattened base; lower end of shaft much flattened and expanded, with the outer and middle trochlea raised above it by a distinct line; inferior foramen small and circular on posterior face, larger and elongate oval on anterior surface, with a faintly indicated, rather broad groove leading into it from above; body of shaft strong and much elongated, outer face plane, viewed from the side, narrow at the lower end, where it extends smoothly onto the outer trochlea, and expanding gradually above to continue upward as a broad, flattened surface; inner face more irregular, but flattened in general, becoming somewhat excavated in its upper section so that it is distinctly concave; meeting the outer face at a sharp angle to form a distinct ridge; posterior face, above the articulation of the hallux, a broad, open groove, deepening above, and marked by sharply projecting edges; facet for articulation of the hallux deeply impressed, located rather high on shaft. Bone without organic matter, ivory white in color.

Measurements. Smallest transverse breadth of shaft 13.0; transverse breadth at base of trochlea 22.5 mm.

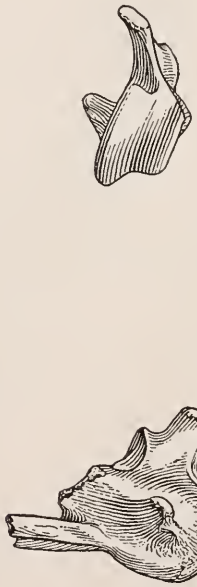
Remarks. In general appearance the metatarsus is so closely similar to that of *Hypomorphnus* as to leave no question as to its near relation to that genus. In its size it is most extraordinary, being truly a giant among hawks. While it is so broken that few definite measurements may be given, its dimensions are easily evident on examining the accompanying illustrations, particularly the plate on which it is photographed beside a metatarsus of a female *Hypomorphnus urubitinga azarae* from Argentina (Plate 1).

From *Wetmoregyps daggetti* (L. H. Miller)[1] from the Pleistocene of California *Titanohierax* differs in the same manner that it does from *Hypomorphnus*. While in total length of metatarsus *Wetmoregyps* may have been near *Titanohierax* the latter has the bone much heavier and

[1]*Morphnus daggetti* L. H. Miller, Condor, **17**, 1915, p. 179, fig. 63 (Pleistocene of Rancho La Brea). For an excellent illustration of the tarso-metatarsus see Howard, H., Carnegie Inst. Washington, Publ. No. 429, 1932, pl. 13.

more robust. The greater elevation of the facet for the hallux in the Bahaman species is especially noticeable.

From the size of the metatarsus *Titanohierax* is supposed to have been nearly twice as large as the existing black hawk of South America with which it is compared.



Figs. 8–9. Proximal end of metacarpal of *Titanohierax gloveralleni*, natural size.

There is also in the collection the head of a right metacarpal bone (Cat. no. 2258) that obviously belongs to this same species. This fragment (figs. 8–9) is generally similar to that of *Hypomorphnus* except for its dimensions, being nearly twice as large as in the living bird.

The size element in this species is found thus in both anterior and posterior limbs, making this the largest known hawk of its group. That it should be found in the Bahama Islands seems most strange. On Exuma it lived with the rodent *Geocapromys* whose bones are found in abundance in the same cave.

Family SCOLOPACIDAE

Capella delicata (Ord). Wilson's Snipe

Scolopax delicata Ord, in reprint Wilson, Amer. Orn., **9**, 1825, p. ccxviii (Pennsylvania).

This migrant from North America is represented by a left humerus and right and left coracoids (Cat. No. 2260) that come from an individual of large size.

The specimens are assigned to this species with some mental reservation as both humerus and coracoids are considerably larger than those of any skeleton of the Wilson's snipe available. The humerus measures 42.1 mm. in total length, and the coracoids 21.8 and 22.4 mm. in the same dimension. In four Wilson's snipe the longest humerus is only 40.4 mm. long, while the smallest is 37.0 mm., this being the size range to be expected in such a species.

The bones from Great Exuma Island do not come from *Capella anthonyi* (Wetmore) described from caves on Puerto Rico, as I have ascertained by comparison with the type material. It is possible that they represent an extinct species, a matter that is left for future consideration when more skeletons of the Wilson's snipe are available for study.

The Wilson's snipe is found throughout the West Indies in its southern flights, and has been recorded from many of the Bahama Islands.

Family COLUMBIDAE

Columba squamosa Bonnaterre. Scaled Pigeon

Columba squamosa Bonnaterre, Tabl. Enc. Méth., **1**, 1792, p. 234. (Guadeloupe Island, West Indies.)

Represented by somewhat fragmentary material, including 5 ulnae, a metacarpal, a coracoid and a femur (Cat. no. 2259), which constitute the first record of this pigeon from the Bahama Islands. As the bird ranges widely through both Greater and Lesser Antilles and has occurred casually at Key West, Fla., its occurrence in the Bahamas in earlier times need occasion no surprise.

In the skeletal elements listed above this species is larger than the white-crowned pigeon, *Columba leucocephala* which is now common in the Bahaman Islands.

OREOPELEIA CHRYSIA (Bonaparte). Key West Quail-dove

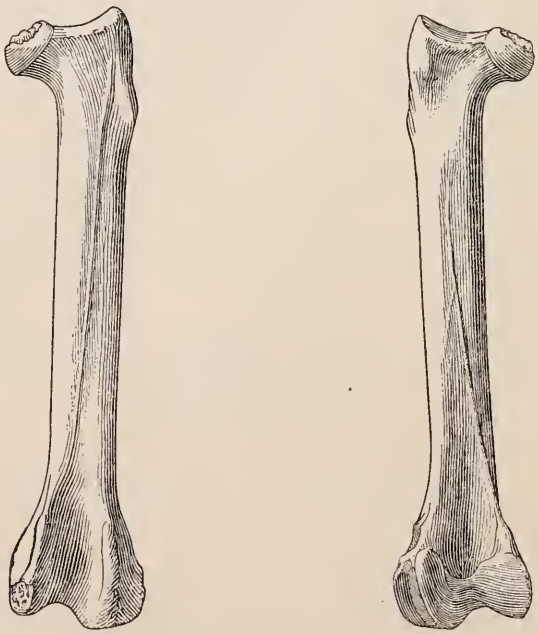
Geotrygon chrysia Bonaparte, Compt. Rend., **40**, 1855, p. 100. (Florida.)

The Key West quail-dove is represented by a humerus and a metatarsus (Cat. no. 2261). The species is one that has been recorded on many islands in the Bahamas.

Family TYTONIDAE

TYTO POLLENS sp. nov.

Characters. Femur (figs. 10–14) similar to that of *Tyto ostologa*



Figs. 10–11. Two views of femur, type, of *Tyto pollens*, natural size.

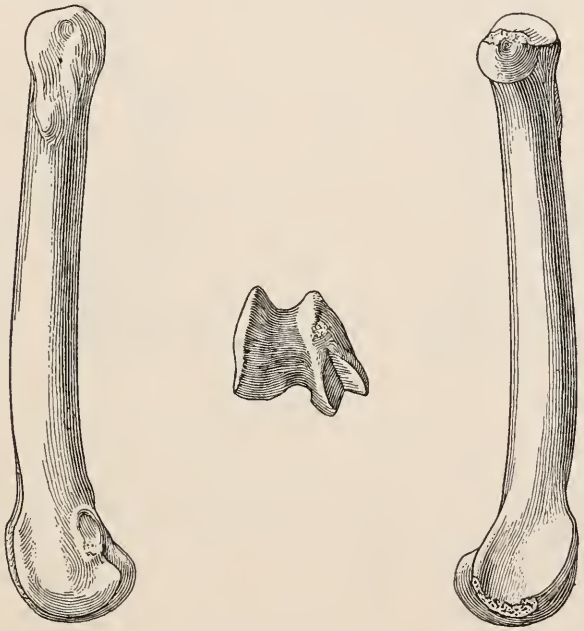
Wetmore[1] but slightly larger; trochanteric ridge larger and more robust.

Description. Type, Museum Comparative Zoölogy Cat. No. 2262,

[1] *Tyto ostologa* Wetmore, Smiths. Misc. Coll., **74**, no. 4, October 17, 1922, p. 2. (From cave deposits at St. Michel de l'Atalye, Republic of Haiti.)

left femur, from cave deposits on Great Exuma Island, Bahama Islands, collected by Mrs. Vivienne Knowles, in 1937.

Head rather small, with a deep depression for the attachment of the ligamentum teres; neck slightly produced; iliac facet rather flattened and elongated; trochanter strong, with a heavily developed trochan-



Figs. 12–14. Three views of femur, type, of *Tyto pollens*, including a profile of the distal end, natural size.

teric ridge that is strongly produced at its lower end; obturator ridge fairly well developed; shaft strong, slightly flattened to an elliptical form from above downward, and straight for three fourths of its length from the proximal end, slightly more flattened distally; anterior muscular line well marked, extending in a nearly straight line diagonally the length of the upper surface of the shaft from below the trochanter to near the base of the external margin of the rotular groove; posterior intermuscular line also well marked, its course roughly parallel to

that of the similar line on the upper surface of the bone; fibular groove sharply angular, fairly deep; external condyle strong, projecting well beyond the level of the internal condyle; internal condyle heavy and broad; rotular groove deeply impressed and wide; intercondylar fossa narrow and openly U-shaped; popliteal area broad and nearly plane, with a sharply angular overhang beneath the intercondylar fossa. Bone brownish white in color, entirely devoid of fatty or similar organic matter.

Measurements. Total length 82.0; transverse breath through head 16.8; transverse breadth through condyles 18.1 mm.; transverse breadth of shaft at center 8.2 mm.

Remarks. This great owl completes the picture of predators on the large *Geocapromys*, since it may be supposed with logic that it harried these mammals at dusk and by night while *Titanohierax* was their nemesis by day. It is probable also that the owl, representative of a group that lives regularly in caverns, was responsible in great part for the deposit of rodent bones through regurgitated pellets accumulated beneath its nests and roosts.

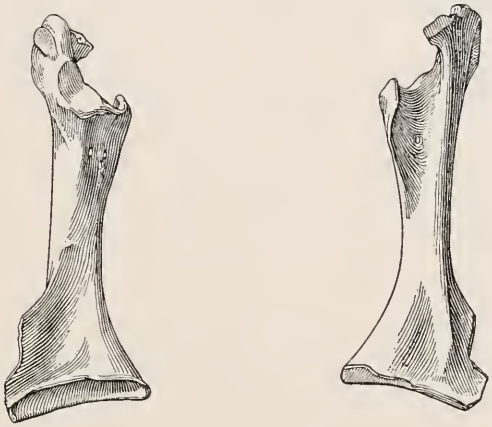
Interest in *Tyto ostologa* of Hispaniola, giant among its kind, is enhanced by the find of the even more robust *Tyto pollens* in the Bahamas, as these two indicate a wide distribution for a peculiar group whose span of existence seemingly was coincident with that of an abundant rodent fauna, and whose disappearance apparently came with the extinction of this prey.

In addition to the femur selected as type there are four other fragments of bone (Cat. no. 2263) in the collection that come from the skeleton of *Tyto pollens*. The head of a right tibio-tarsus agrees with the corresponding bone in *Tyto ostologa* but is slightly larger. Its transverse diameter is 17.5 mm.

The shaft of a left metacarpal II is also more robust in comparison with that of the Haitian species, as is the proximal end of a left ulna. Both bones are too fragmentary to afford satisfactory measurements. A left coracoid, nearly complete (figs. 15–16) is slightly larger, and has the sternal facet proportionally larger, indicating a bird of definitely larger size, though here again small missing portions on proximal and distal ends prevent accurate measurements.

Comparison of all these has been made with a considerable series of

bones of *Tyto ostologa* from Haitian caves in a collection that I have under study, but on which report has not yet been made. The conclusion that the bird of the Bahamas was somewhat larger and stronger



Figs. 15–16. Coracoid of *Tyto pollens*, natural size.

than that of Haiti comes from a consideration of size variation in the Haitian material mentioned, as well as from study of individual variation in the skeleton of the living *Tyto alba perlata*, the barn owl of the United States.

Family STRIGIDAE

Speotyto cunicularia (Molina). Burrowing Owl

Strix cunicularia Molina, Sagg. Stor. Nat. Chili, 1782, p. 263.

A broken metatarsus (Cat. no. 2264) comes from this species, resident on many islands in the Bahamas.

Family PICIDAE

Colaptes chrysocaulosus Gundlach. Cuban Flicker

Colaptes chrysocaulosus Gundlach, Ann. Lyc. Nat. Hist. New York, **6**, 1858, p. 273. (Cuba.)

A left humerus and a left tibio-tarsus (Cat. No. 2265) of a flicker agree so minutely with bones of the Cuban bird that they are not to be separated specifically, though it is probable that the Bahaman bird in life may have had color characters that set it apart as a distinct geographic race, as is true of the same bird on Grand Cayman Island today.

These remains present a new record for the Bahama Islands, and a considerable extension of range for the species.

Centurus superciliaris (Temminck). West Indian Red-bellied Woodpecker

Picus superciliaris Temminck, Planch. Col., livr. 73[e], **4**, 1827, pl. 433 and text. (Cuba.)

A right metatarsus (Cat. no. 2266) comes from this woodpecker, widely distributed as a species in the Bahaman Islands. It is not practicable with present skeletal material to determine the subspecies to which this specimen belongs, but it may be noted that it is the first record for Great Exuma Island. It may represent an unknown geographic race, the three forms recognized at present from the Bahama Islands being restricted to Great Bahama, Abaco and Watling Islands respectively.

The specimen has a length of 23.5 mm.

Family CORVIDAE

Corvus nasicus Temminck. Cuban Crow

Corvus nasicus Temminck, Planch. Col., livr. 70, **2**, 1826, pl. 413. (Cuba.)

Among the other birds from Great Exuma Island there are several bones from crows, including a complete humerus from an immature individual with the bone still porous, parts of two other humeri, and an ulna with the olecranon missing (Cat. nos. 2267–2268). These come from a species smaller than *Corvus leucognaphalus* and larger than *C. palmarum*. The identification of this species has been somewhat difficult, and though at first I considered it an extinct form unknown to science, I have finally concluded that it is *Corvus nasicus*, the Cuban

crow, which in addition to its Cuban range is recorded from Great Caicos Island in the southern Bahamas.

No skeletal material of *C. nasicus* is at this time available to me but from examination of skins it appears that the wing in this species is intermediate in length between that of *leucognaphalus* and *palmarum* so that in wing length *nasicus* has the same relative size position as do the bones from Great Exuma Island. It is possible in some of the skins of *nasicus* at hand to determine the approximate length of the ulna which agrees with that of the ulna from Great Exuma, being definitely shorter than that of *leucognaphalus*. On this basis these bones are identified as *C. nasicus*, which seemingly formerly had an extended range through the Bahama Islands.

Family MIMIDAE

Margarops fuscatus (Vieillot). Pearly-eyed Thrasher

Turdus fuscatus Vieillot, Ois. Amer. Sept., **2**, 1807, p. 1, pl. 57 bis. (Santo Domingo; Puerto Rico.)

Two humeri (Cat. no. 2269) of this common bird were obtained.

Family TURDIDAE

Mimocichla plumbea (Linnaeus). Bahama Thrush

Turdus plumbeus Linnaeus, Syst. Nat., ed. 10, **1**, 1758, p. 169. (America.)

Represented by a left humerus (Cat. no. 2270).

EXPLANATION OF PLATE

PLATE

Type (at right) and metacarpal (upper left) of *Titanohierax gloveralleni* compared with similar bones of *Hypomorphnus urubitinga azarae*, U. S. Nat. Mus. No. 319432, female (natural size).

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
Vol. LXXX, No. 13

GEOGRAPHICAL VARIATION IN THE SAVANNAH SPARROW

By James L. Peters and Ludlow Griscom

With One Colored Plate

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
January, 1938

JAN 19 1938

79.421

No. 13. — *Geographical Variation in the Savannah Sparrow*

By James L. Peters and Ludlow Griscom

The study here presented of a particularly complex and difficult group of Sparrows originally grew from small beginnings. Many years ago Mr. A. M. Bailey sent some remarkably black Savannah Sparrows from Louisiana to Outram Bangs for identification. He never lived to do so, but both of us were aware that he felt most strongly that their proper identification should involve a monographic study of the whole group. In the Auk, April, 1932, p. 230, Emilio and Griscom made an effort to determine the status of the Labrador Savannah Sparrow, *Passerculus sandwichensis labradorius* (Howe) in Massachusetts, and published records of certain specimens assigned to this subspecies. Griscom gained the strong impression that there was ample room for a critical study of this race, and persuaded Peters to undertake it. To be frank, Peters became convinced that *labradorius* was valid, and Griscom became equally convinced that certain specimens recorded by him as *labradorius* were no such thing. Finally several recent studies of Savannah Sparrows had been presented, based solely on the material available to the author at his own institution, and these authors had reached radically different conclusions. Experience has proved that the resolution of such differences of opinion depends upon a thorough monographic study based upon practically all the pertinent material available.

We accordingly proceeded to assemble this material, and are consequently under the greatest obligation to numerous colleagues and institutions, who cheerfully loaned us absolutely essential and invaluable series and patiently permitted us to keep them an unusually long time. At the end of the article will be found a tabular list of the material examined, with the collections from which they came. We hereby extend our heartiest thanks to our numerous colleagues in charge of or owning these collections.

In this connection, however, we wish to make further remarks about pertinent material. The specimens listed by no means represent the entire series in every institution, but in most cases critically selected or critical specimens only. Thus Griscom went over the entire collections of the American Museum and the Biological Survey, and selected only those specimens to be sent to Cambridge, which needed critical study or were in any way of importance from the standpoint of geographical distribution, variation, etc., or were needed to supplement series already in Cambridge. It follows that one or another of us has examined at least 1000 specimens in addition to those

officially listed beyond. It also follows that we see no point whatever in printing an itemized list of every specimen seen. It would make our paper twice as big, but not twice as good. In the case of the eastern Savannah Sparrow, for instance, its exact characters are discovered by the examination of *breeding* birds, and we borrowed enough material to examine specimens from every section of its breeding range. It is perfectly well known to be an abundant migrant in the Atlantic States as well. It would have been a simple matter to borrow a thousand migrant specimens from the great eastern collections, and we could have printed an itemized list. This type of "padding" makes a paper appear superficially more imposing, perhaps, but adds nothing to scientific knowledge.

We both belong to the generation which grew up in the belief that there were three "species" of Sparrows in this genus, the Ipswich Sparrow, the Savannah Sparrows proper, and the "large-billed" Sparrows (the *rostratus* group), little known birds with uncertain breeding ranges and distressing migratory habits, which were radial rather than the more stereotyped north-south trend. Modern research has conclusively proved that the large-billed Sparrows intergrade with the salt marshes Sparrows (*beldingi* and "*bryanti*" of authors), and that there is a complete chain of intergrading characters between the extremes in Lower California and the western races of the "Savannah" Sparrow. A sounder biological viewpoint makes it equally impossible to maintain the Ipswich Sparrow as specifically distinct. We are here primarily concerned with the Savannah Sparrows proper, as it is with this group of subspecies that the examination of all existing pertinent material can throw light on a particularly puzzling and difficult problem. No effort has been made to "monograph" the *rostratus* group on a similar scale. Several ornithologists in recent years have examined the existing pertinent material, and have put on record the possible inferences which can be drawn from it. We have contented ourselves, therefore, with a resumé of the present state of knowledge as regards racial variation in this group, and merely point out what material is needed in the way of additional specimens before the current inferences can be changed into proved facts.

The colored plate was made possible by a grant from the Milton Fund of Harvard University.

All measurements are in millimeters. Those in brackets not only represent the absolute maxima and minima, but indicate that no specimen furnished a dimension in between the one in brackets and the next one given.

1. Passerculus sandwichensis princeps Maynard

Passerculus princeps Maynard, Amer. Nat., **6**, 1872, p. 637. (Ipswich Beach, Massachusetts.)

Diagnosis. Palest of the Savannah Sparrows (in the popular sense) Similar to *P. s. sandwichensis* in size, but the bill averaging shorter and slightly thicker. General coloration above with brown and gray predominating, the black areas duller than in any of the other races; rusty wing edgings paler, becoming whitish on their outer margins; streaks below narrower and less numerous, paler, decidedly brownish with little or no trace of blackish centres. In spring the markings on the upper surface are more contrasted, the blackish feather centers standing out more conspicuously; in this plumage most nearly resembles the fresh fall plumage of *nevadensis*, which however has blackish streaks below. In autumn *princeps* is best characterized by the broad ashy veilings of the feathers of the upper surface.

Measurements.

	Wing	Culmen	Depth of bill
12 ♂	[84], 79.3–73.5 [72.4];	[11.6], 11.5–10.6 [10.1];	[6.1], 6.1–5.6 [5.4].
12 ♀	[78.8], 76.9–70.7 [70.6];	[11.4], 11.2–10.4 [10.0];	[5.9], 5.8–5.5 [5.2].

Range. Breeds only on Sable Island, Nova Scotia, where it is the only resident land bird. In migration along the outer beaches of the Atlantic coast from southern Maine to northern Georgia. Winters commonly from the south side of Long Island southward, less numerously from eastern Massachusetts. Arrives on coast of Massachusetts about October 10th, Long Island, Nov. 1st. On Long Island, spring migration northward takes place chiefly in the last two weeks of March, in Massachusetts chiefly the first ten days in April; latest migrant specimen examined, 2 ♀ Monomoy Island, Mass., 20 April, 1889. 1 MCZ, 1 F. H. Kennard coll.

Discussion. While the Ipswich Sparrow has been maintained as a distinct species ever since it was first described, there are no reasons (except possibly sentimental ones) that would warrant the continuation of such a course.

There is no *absolute* difference of any kind between this form and one or more races of *P. sandwichensis.* In size it is not only no larger than *P. s. sandwichensis*, but the smallest specimens are smaller than the largest specimens of *P. s. savanna.* The pallor of its coloration is not very marked when compared with *P. s. nevadensis*, and is exceeded by

certain races of the *rostratus* group in Lower California. *P. s. princeps* gives a far greater impression of distinctness in fresh fall plumage, when the feather edgings form a broad gray veiling that more or less overlays the ground coloration, than when a series of April killed birds is viewed; such a series then appears as a large, rather pale Savannah Sparrow, showing just the characters one would expect, knowing the habitat of the bird.

While it is quite true that practice enables the observer readily to identify the Ipswich Sparrow in life, as it darts away through the beach grass of its favorite dunes, we have yet to learn that this is a sound biological criterion for specific distinctness. The same argument applies with even greater force on the coast of southern California, where any one can distinguish *beldingi* and *rostratus* from the swarms of the more typical wintering Savannah Sparrows. And yet it is positively and finally determined that these marked extremes are perfectly connected by a chain of intermediates occupying other isolated and more or less remote geographic areas. The fact, therefore, that the Ipswich Sparrow is readily distinguishable from *labradorius* and *savanna*, the only races with which it ever associates, has nothing whatever to do with a final evaluation of its relationship to the group as a whole.

2. Passerculus sandwichensis sandwichensis (Gmelin)

Emberiza sandwichensis Gmelin, Syst. Nat., **1**, 1789, p. 875.
(based on the Sandwich Bunting of Latham, Gen. Syn., **2**, p. 202, no. 47. Aoonalashka and Sandwich Sound = Unalaska Island.)
Emberiza arctica Latham, Ind. Orn. **1**, 1790, p. 414.
(Same basis as Gmelin's name.)
Emberiza chrysops Pallas, Zoogr. Rosso-Asiat., **2**, 1811, p. 45, pl. 48, f. 1. (Unalaska.)

Diagnosis. Largest (average) of the races of *P. sandwichensis* with long and proportionately slender bill, depth at base about one-half the length of culmen; longest primaries exceeding shortest secondaries by length of tarsus. In spring, general coloration above with black and gray predominating, brown element reduced; interscapulars with black centers separated from the conspicuous grayish white edges by a very narrow area of grayish or rusty brown; lores and superciliary stripe bright yellow, the latter extending well beyond posterior border of the eye; wing coverts and inner secondaries more or less broadly edged with pale or rusty isabelline. Streaking underneath not conspicuously broad or blackish.

In fall, general coloration browner above, sides of head and hind neck suffused with pale buffy yellow, strongest in immature birds; a light brownish wash across the breast, also strongest in immature birds.

Measurements. Based on breeding specimens from the Aleutian Islands and the Alaska Peninsula.

	Wing	Culmen	Depth of bill
20 ♂ [78]	77.1–74.5 [72.8];	[13] 12.6–10.8 [10.5];	[6.6] 6.5–5.8 [5.5].
8 ♀ [78.5]	76.5–73.4 [72.5];	[12.5] 12.2–12 [11.7];	[6.8] 6.4–5.9 [5.8].

Range. Breeds on the eastern Aleutian Islands: Unalaska, Unimak, Amak, Amaknak, Tigaldo, and Rootok; not definitely recorded from any of the Aleutians east of Unalaska. Also adjacent part of Alaska Peninsula: Izembek Bay and Chignik. Earliest specimen examined, Urilla Bay, Unimak Id., 7 May, 1925, ♂ collected by O. J. Murie, specimen in M. C. Z. Latest date in fall, 6 Oct., 1899, a few seen and two young secured (Bishop, No. Am. Fauna no. 19, 1900, p. 83). Eggs 1 June, 1918, Chignik, Alaska Peninsula, Franklin J. Smith, ♂ and set of four eggs in Thayer collection, now in M. C. Z.

Winters. From the coast of British Columbia (probably including Vancouver Island) to northern California, 22 Sept. 1888 — 1 May, 1890.

Migration. Apparently unknown on the coast of Alaska north and east of Sitka. Swarth (Univ. Cal. Publ. Zool., **7**, 1911, p. 84–85) suggests that the migration route of this species after leaving the Alexander Archipelago is directly across the Gulf of Alaska to its breeding grounds, a theory which is partly substantiated by the specimen taken at sea in lat. 47° N., long. 152° 1′ W. by W. H. Dall, 15 Sept. 1871 (specimen in U. S. Nat. Mus. examined).

Accidental on St. Paul Island, 24 Sept. 1917 (G. Dallas Hanna, specimen in U. S. Nat. Mus. examined).

Discussion. P. s. sandwichensis is by far the most satisfactory of the western subspecies; there seems to be no great amount of variation in size, and the variable color characters that make a diagnosis of some of the other races so difficult, are reduced to a minimum. An occasional specimen is found with a greater extent of brown on the dorsal surface and more rufescent wing edgings than is commonly shown by the average bird, but even such specimens are readily determined by the large bill, long wing and longer wing tip.

3. Passerculus sandwichensis savanna (Wilson)

Fringilla savanna Wilson, Amer. Orn., **3**, 1811, p. 55, pl. 52, fig. 3. (Savannah, Georgia.)

Passerculus sandwichensis bradburyi Figgins, Proc. Colorado Mus. Nat. Hist., **2**, April, 1918, no. 1, p. 2. (James Island, South Carolina.)

Diagnosis. A medium-sized, brown Savannah Sparrow with relatively stout bill; its depth equal to or exceeding half the length of the culmen. Similar to *P. s. oblitus* and of approximately the same size, but browner throughout, the brown and buff elements strongly developed. Similar also to *P. s. labradorius*, but less heavily streaked below and streaks browner, less black; black areas above much less developed, the browns correspondingly increased, particularly on crown and interscapulum. Very close to *P. s. crassus*, differing only in averaging slightly smaller. (cf. plate, fig. 2)

Measurements.

New England breeding birds

	Wing	Culmen	Depth of bill
23 ♂	[74] 72.1–66.2 [65];	[11.2] 10.9–10.1 [—];	[6.1] 6.0–5.1 [4.9].
12 ♀	[68.9] 67 –62.6 [62.5];	[11.] 10.6– 9.8 [9.4];	[5.6] 5.5–5.2 [5.1].

Type series of *bradburyi*

2 ♂	68.4–65.1	10.8–9.7	5.9–5.8
9 ♀	[67.5] 66.9–65.1 [63.5];	[10.9] 10.8– 9.6 [9];	[—] 5.9–5.3 [—].

Michigan breeding birds

9 ♂	[71.9] 71.8–66.8 [65].		
6 ♀	[66] 65.6–63.8 [63].		

Northwestern Ohio

6 ♂	[70.5] 69.4–66 [65.9];	[10.8] 10.7–10.5 [10.2] ;	5.5–5.4.
1 ♀	66.4 ;	11 ;	5.4.

Pennsylvania

1 ♀	65.3 ;	9.8 ;	5.

Range. Breeds from Gaspé Peninsula, Quebec, and the Magdalen Islands, Gulf of St. Lawrence, south to the coast of northern New Jersey, where it is a common summer resident on the outer beaches, west across southern Ontario and western New York to Michigan; south to northern Illinois, northern Indiana, northern Ohio, western Pennsylvania, and northern West Virginia; often absent from large areas in the inland part of its range, especially in the Transition Zone.

Winters chiefly east of the Alleghanies from middle parts of the Carolinian zone south to the Florida Keys, Bahama Islands, (Nassau 2♂ 3 Mar. and Apr. 1877, C. J. Maynard, M. C. Z. 103548, 103549); eastern Mexico and Yucatan (Rio Lagartos, ♀, 18 Apr. 1893 W. W. Brown, M. C. Z. 115289); most numerous in the southeastern United States, rarely north to Long Island and the coast of southern New England.

Migration. In the Atlantic states the Savannah Sparrow arrives in the southern part of its breeding grounds early in April; the migration period extends throughout the rest of the month and into the early part of May; a few birds, chiefly females, linger on their wintering grounds until the first week in May (the type series of *bradburyi* was taken on James Island near Charleston, South Carolina, between 3 and 9 May) and casually into summer (July, Cobbs Island, Va. specimen in A.M.N.H.). The southward migration commences about the middle of September, and in the latitude of Boston continues until about the 25th of October; further south, on the coast of New Jersey, migrants are commonly found until about the middle of November.

Discussion. Very large series (555 specimens) examined from practically all the principal regions throughout the breeding and winter ranges. As might be expected there is the usual amount of individual variation present; this is chiefly noticeable in the depth of the rusty edgings of the wing coverts and secondaries, and in the amount of rusty and extent of the white or grayish white edges of the interscapular region. Occasional specimens are found in which the bill is more slender than in the great majority.

An important feature of the fall plumage of *P. s. savanna* is the strong buffy wash on the hind neck and sides of the head, in some cases also extending across the chest. This seems to be characteristic of the fresh fall plumage of both adults and immature, but soon is lost, and is rarely seen in birds taken after the tenth of October, though it is very characteristic in birds collected during late August and September.

P. s. bradburyi was described by Figgins from a small series of birds taken at James Island, S. C. Figgins was apparently misled in believing that the birds were breeding there, though no definite evidence to this effect was presented. Furthermore, females predominated to such an extent that the measurements were pulled down below the average, leading him to include small size as one of his characters; another character, the buff "submalar" stripe is characteristic of the females of *P. s. savanna*. While Figgins does not state what comparative material was available to him, it is quite evident from his description, that his

series of *P. s. savanna* must have been sadly inadequate. Whether or not the Savannah Sparrow breeds sporadically and locally on the coast of the southern States is consequently a matter of no taxonomic importance. The facts are that all the specimens examined (mostly in very frowsy, worn plumage) are indistinguishable from specimens in comparable plumage from the southern half of the normal breeding range.

Owing to the interest attached to state and local avifaunas, we list the following extreme records, all based, of course, on specimens examined.

Breeding birds. Magdalen Islands; Gaspé County, Quebec; Beach, Illinois (Chicago Acad. Sci.); northern Ohio (Ohio State College), southern Michigan (Univ. of Mich.); Cresson, Penna (Coll. J. Dwight); Cobbs Island, Virginia, July 4, 1891, coll. W. C. Rives (Dwight Coll.)

Winter Records. From every Atlantic State, Massachusetts south to Florida (Florida Keys); also Arkansas (Mississippi County) and coast of Louisiana; Bahamas and Yucatan as cited above.

Migration records. Wisconsin, Lake Koshkonong; Iowa, Storm Lake, Sept. 24, 1887; Indian Territory, Fort Reno, Sept. 29 and Oct. 13, 1890; Mexico, Tamaulipas, Matamoros, Nov. 9, 1908.

We have seen little or no material of *savanna* shot in migration or in winter from west of the Alleghanies. The exact status of this race in many areas within the extreme limits cited above must be left to local students, competent to collect judiciously.

4. Passerculus sandwichensis labradorius Howe

Passerculus sandwichensis labradorius Howe, Contrib. N. Amer. Orn., No. 1, Oct. 14, 1901, p. 1 (Lance au Loup, Labrador).

Diagnosis. A dark Savannah Sparrow with relatively stout bill; its depth more than half the length of the culmen; similar to *P. s. savanna*, and of about the same size, but darker throughout, the black areas more extensive.

In spring general coloration above black, grey and brown, the black areas conspicuously developed, browns reduced, the white interscapular edges less developed than in *savanna;* lateral crown stripes largely black with little or no brown in extreme specimens; lores and superciliary stripe bright yellow, entire auricular region averaging darker than in *s. savanna;* streaking beneath dark brown or black, and heavier. (cf. plate, fig. 3)

In fall the same general differences exist, but are more pronounced and obvious.

Measurements of breeding birds.

	Wing	Culmen	Depth of bill
Labrador			
10 ♂	[73.4] 71.9–67 [65.1];	[11] 10.8– 9.6 [9.1];	[6.] 5.9–5.3 [5.2].
6 ♀	[72.2] 68.5–64.8 [64.5];	[10.5] 10.4– 9.7 [9.5];	[5.6] 5.5–5.1 [4.9].
Newfoundland			
8 ♂	[73.1] 73 –70.7 [69.6];	[10.8] 10.5–10.1 [10] ;	[6] 5.6–5.3 [5.2].
6 ♀	[67.5] 67. –64.8 [64.1];	[10.4] 10.3–9.8] [9.5];	[6.1] 5.5–5.2 [5.1].

Breeds. On the coast of the Labrador Peninsula south to the Mingan Islands; Newfoundland.

Migration. Earliest spring arrival examined, Lance au Loup, Labrador, 4 May, 1900, collected by Ernest Doane; latest fall specimen, Curslett, Newfoundland, 11 Oct.

Winters most commonly in Florida (large series south to the Tortugas), north casually to Rhode Island and Massachusetts; of accidental occurrence in Cuba. Extreme dates in Florida are Cedar Keys, 10 Nov., 1870, C. J. Maynard, to 21 April, 1887, Tarpon Springs, W. E. D. Scott. In *migration* chiefly along the Atlantic seaboard, apparently casual inland; Massachusetts dates are April 8–May 19; Sept. 24–Nov. 14. All extreme records are listed below.

Cuba, Habana, Cerro, Dec. 16, 1932

Rhode Island — Warren, Jan. 2, 1887, Batchelder coll.

Massachusetts — Gurnet, Plymouth, Feb. 22, 1930, J. L. Peters

Maine, Lake Umbagog, Sept. 24, 1890, 1 ♂ in. Boston Soc. Nat. Hist.

Massachusetts — no locality, April 8, 1887, 1 ♂

Plum Island, Newbury, May 19, 1936, 1 ♂, L. Griscom, in Peabody Mus. Salem

Ipswich, April 9, 1883, 1 ♂

Swampscott, Nov. 14, 1881, 1 ♀ ; Oct. 30, 1882, 1 ♀

Revere, Oct. 6, 1885, 1 ♂, Batchelder coll.

Medford, Sept. 22 and 24, 1890, 2 ♀, Thayer coll.

Brookline, April 26 and 28, 1895, 2 ♂, Thayer coll.

Cambridge, April 11, 1885, 1 ♂ ; May 17, 1892, 1 ♀ ; May 11, 1872, 1 ♀

Concord, April 12, 1888, 1 ♂

Bridgewater, Oct. 13, 1906, 1 ♂, Bent coll.

Norton, April 21, 1888, Bent coll.

Rhode Island, Cranston, April 19, 1891, H. S. Hathaway, no. 692; Charlestown, Oct. 19, 1933, H. S. Hathaway, no. 1279
New York, Flatlands, Long Island, Dec. 10, 1889, A.M.N.H.
Maryland, Kensington, Oct. 17 and 26, 1894, 3 ♀, Dwight coll. Franklintown, Oct. 22, 1892, 1?, A.M.N.H.
Washington, D. C., May 7, 1900, 1 ♀, Thayer coll.
Georgia, Chatham Co., Hutchinson Isl., Oct. 7, 1934 and May 14, 1933, 2 ♀, Ivan R. Tomkins coll.

Discussion. With over 150 specimens before us, the validity of this race is thoroughly established. The recognition of migrant and winter specimens is, however, a critical matter, and should not be attempted by anyone without an adequate series of Savannah Sparrows in *exactly comparable* plumage. Needless to say, with progressive wear the lighter edges to the feathers of the upperparts of *savanna* disappear, leaving an increasingly darker and more heavily streaked bird. Worn breeding specimens of the two races are often indistinguishable; fresh fall specimens of *labradorius* look suspiciously like certain more worn mid-winter specimens of *savanna*, and sometimes the chief aid in placing such specimens will be the deeper, richer or more rusty edgings of the primaries in *labradorius*. We have been in considerable doubt about naming several individuals. These, perhaps, represent the extreme variation away from *labradorius* in Newfoundland. About one third of the 60 breeding specimens from this island examined are intermediate between *labradorius* and *savanna*. It follows that sight records of this race are out of the question, in adding anything definite to our knowledge. While it is quite possible to observe slightly darker and paler Savannah Sparrows among our migrants in the east in life, only critical comparison of such birds in the hand can settle whether the darker bird was really a *labradorius* or a dark extreme or more worn specimen of *savanna*. It is characteristic of modern "opera glass ornithology" that the only sight record of *labradorius* published to date comes from an inland region without an authentic record, and that it was made in all sincerity by an observer blissfully unaware of nearly everything written above, who never laid eyes upon an authentic specimen or compared it with a *savanna*! Let us hope there will never be another such observation.

5. Passerculus sandwichensis oblitus subsp. nov.

Type no. 23851, Nat. Mus. Canada; ad ♂, Fort Churchill, Manitoba; 4 June, 1930; collected by P. A. Taverner.

Diagnosis. A medium sized gray Savannah Sparrow with relatively stout bill, its depth more than half the length of the culmen. Similar to *P. s. savanna* and of about the same size, but grayer throughout; the brown and buff elements reduced or lacking: similar also to *P. s. labradorius* in the depth and extent of the streaking of the underparts and development of black areas above, but browns much paler and reduced in area, often lacking; reddish wing edges much paler. In spring plumage recalling *P. s. nevadensis* in gray, black, and white coloration above, but with black areas more extensive, streaking below much heavier, and yellow superciliary brighter and more extensive.

In autumn most nearly resembling *P. s. labradorius*, but blacker, less brownish; distinguishable at a glance from *P. s. savanna* by almost complete absence of reddish brown; the color which predominates in the Atlantic slope bird at that season. *P. s. nevadensis* in fall is *paler* and *grayer* than *oblitus*, and is always readily separable by its slenderer bill.

Measurements of breeding birds only.

	Wing	Culmen	Depth of bill
11 ♂	Ft. Churchill, Manitoba [74.4] 74 –69.4 [67.4];	[10.4] 10.3– 9.9 [9.8];	[5.7] 5.6–5.1 [5.0].
12 ♂	Lake St. John, Que. [73] 71 –67.9 [66.7]		
4 ♂	James Bay, Ont. 69.3–66.5		
6 ♂	Kapukasing, Ont. 72.8–67.8		
4 ♂	Pt. Arthur, Ont. 70.6–68.9		
1 ♀	Lake St. John, Que. 65.2		
3 ♀	James Bay, Ont. 70.5–62.7	9.7– 9.5	5.2
3 ♀	Kapukasing, Ont. 66. –63.9	10.2– 9.4	5.4–5.3
4 ♀	Pt. Arthur, Ont. 67. –63.6		
1 ♀	Minnesota 66.6		

Range. *Breeds* from west side of Hudson Bay (Ft. Churchill) southward east of the Prairies to northern Minnesota (northeastern Iowa?) and Lake Superior, eastward to western Ontario and Lake St. John, Quebec; Mattagami R.

Migrates chiefly between the western slope of the Alleghanies and the eastern border of the Great Plains, apparently common in the fall in the Great Smokeys and in eastern Iowa, and *winters* chiefly along the coasts of eastern Texas and southern Louisiana; probably adjacent parts of Mississippi, but no specimens examined; casual in eastern Oklahoma in winter.

No satisfactory dates of spring arrival available, but specimens from northern Illinois Apr. 4 and 8; the race still present on the Louisiana coast May 13.

Earliest specimen from Louisiana examined, Nov. 27 and last specimen from northern United States, Oct. 24; a series from the Great Smokeys last week in October (Chicago Acad. Sci.).

Extreme records. 1 ♀ Lawrence, Kansas, 26 Oct. 1907; Buncombe Co., North Carolina, 1 ♀ 23 Mar. 1895; Mt. Pleasant, South Carolina, 1 ♂ 13, Nov. 1918, A. T. Wayne, Sanford coll. Elba Island, Georgia, coll. Ivan R. Tomkins.

Discussion. The description of another race of *Passerculus sandwichensis* in eastern North America calls for a certain amount of explanation. With the great series of birds before us, we were surprised to discover that the brown, rusty and black Savannah Sparrows of Labrador and Newfoundland are replaced in the interior by a race in which the browns and buffs are suppressed and replaced by much more grayish and black tones,— a condition particularly noticeable in the autumn. It would be entirely illogical to lump so well characterized a form with either *labradorius* or *savanna* and then recognize *brooksi* and all of the races of the species described from southern and Lower California. It has become practically an established policy of American ornithologists to consider North America east of the 100th meridian and north of Charleston, S. C. as an area in which geographical variation simply does not take place. The reasons for such a belief no doubt extend back a couple of generations, when subspecific differences were either unrecognized or at least believed unworthy of recognition, but we think there is another even more important cause.

Institutions on the Atlantic coast are rich in material from their own region, but deficient in specimens from the interior and from Canada; conversely the collections in the interior, while possessing adequate series of migrants from their fields have little or no material

from the Atlantic coast. As a result, comparable and adequate series have never been assembled for critical study. The existence of the small series in the M. C. Z. from Lake Koshkonong, Wisconsin taken in the fall and another from southern Louisiana taken in the winter many years ago, led Outram Bangs, with his customary keenness, to suspect a situation, such as now turns out to be the case. Remarkably black specimens from Louisiana were sent for identification to Bangs by A. M. Bailey, and their determination was unfinished at the time of the former's death. Thus it will be seen that this entire revision was originally concerned with the identity of this interior race.

As would naturally be expected, *oblitus* intergrades with *nevadensis* where the two forms meet. On the area of intergradation we find two types of intergrades; thick-billed birds with the paler coloration of *nevadensis* and slender billed birds like *oblitus* in color. The allocation of such intermediates is entirely a matter of opinion. They may be identified on migration as readily as on the breeding ground. We have breeding birds from Manitoba, Lake Winnepegosis, York Factory, Norway House; Winnepeg (where the majority of specimens are *nevadensis*); North Dakota; eastern Iowa; on migration in Oklahoma and Texas. The darker birds with slender bills closely resemble *anthinus*, except that they are more heavily streaked below.

Material Examined

Breeding

Manitoba	Ft. Churchill	11 ♂	all breeding, Nat. Mus. Canada
Ontario	James Bay	1 ♂ 3 ♀	breeding season, Nat. Mus. Canada
	Kapukasing	6 ♂ 3 ♀	Nat. Mus. Canada
	Pt. Arthur	4 ♂ 5 ♀	Batchelder coll.
York Factory	Hudson Bay	4 ♂ 1 ♀	Biol. Survey
Quebec	Lake St. John	12 ♂ 1 ♀	Batchelder coll.
Minnesota	Duluth	1 ♂ 1 ♀	M. C. Z.

Spring Migrants

Ontario	Point Pelee	1 ♂ 1 ♀	May 13, 1905 and May 29, 1913 Nat. Mus. Canada
Wisconsin	Lake Koshkonong	3 ♂	April 28, 1894, M. C. Z.
	no locality	1 ♂ 1 ♀	May 18, 1866, M. C. Z.
	Delavan	1 ♂	19 May, Chic. Acad. Sci.
Iowa	Grinnell	—	M. C. Z.

Ohio	Waverly	1♂	5 May, Ohio State Mus.
Illinois	Roby	2♀	Chi. Acad. Sci.
	Calumet Lake	1♀	Chi. Acad. Sci.
	Warsaw	1♂	Batchelder coll.
	Worth	1—	Chicago Acad. Sci.
Michigan	Petosky	1♂	May 21, 1888, Dwight coll.
	Oden	1♀	May 17, 1888, M. C. Z.
	Ann Arbor	1♀	Univ. of Mich.
Minnesota	Aitlan	♀	18 May, U. of Minn.
	Minneapolis	♀	23 May, U. of Minn.
	Fall Migrants		
Michigan	Gr. Rapids	1♀	Sept. 17, 1891, Thayer coll.
Illinois	Beach	1♂	Chicago Acad. Sci.
	Lake Co., L. Marie	1♂ 1♀	Chicago Acad. Sci.
	Skokie Marsh	1?	Sept. 22, 1908, Chicago Acad. Sci.
	Lemont	3♂	Oct. 5, 1933, Chicago Acad. Sci.
	Adams Co.	2♂	Sept. 18, 1888, Batchelder coll.
	Quincy	2♀	Sept. 14 and Oct. 4, 1888, Batchelder coll.
	Addison	1♂	12 Oct., Ohio State
	Elk Grove	1—	7 Oct., Ohio State
Wisconsin	Lake Koshkonong	5♂	Sept. 7–Oct. 22, 1893, M. C. Z.
	Delavan	1♂	Oct. 24, 1927, Chicago Acad. Sci.
	Camp Lake	1♀	Chicago Acad. Sci.
	No. Freedom	1♀	Sept. 24, 1904, Thayer coll.
Iowa	Storm Lake	2♀	Thayer coll.
	Polk Co., Des Moines	1♂	Univ. of Iowa
	Polk Co., Commerce	2♂ 1♀	Univ. of Iowa
	Hamilton Co.	2♀	Univ. of Iowa
Ohio	Grand Reservoir	1♂	19 Oct., Ohio State
Tennessee	Great Smokey Mts.	10♂ 2♀	Chicago Acad. Sci.
North Carolina	Buncombe Co.	1♀	M. C. Z.
South Carolina	Mt. Pleasant	1♂	Sanford coll.
Kansas	Lawrence	1♂	Thayer coll.
Texas	Fannin Co.	1♂	Nov. 2, 1885, M. C. Z.
	Seabrook	1♀	Dwight coll.
	Brownsville	1♀	Thayer coll.
Arkansas	Mississippi Co.	2♂ 2♀	Oct. 18–Nov. 27, 1870, M. C. Z.

Winter Residents

Georgia	Elba Island	1 ♂	Feb. 17, 1936, coll. Ivan R. Tomkins
Louisiana	no loc.	1 ♂ 1 ♀	M. C. Z.
	New Orleans	9—	M. C. Z.
	Ft. Pipee	1 ♀	M. C. Z.
	Last Id.	1 ♂	M. C. Z.
	Chenier au Tigre	3 ♂ 2 ♀	Chicago Acad. Sci.
	Avery Island	3 ♀	May 12 and 13, Chicago Acad. Sci.
Oklahoma	Ft. Reno	1 ♂	M. C. Z.
Texas	Dallas	1 ♀	M. C. Z.

6. Passerculus sandwichensis crassus subsp. nov.

Type. No. 22033, Thayer Collection, now 322033, Mus. Comp. Zool.; ♂, probably immature, Sitka, Alaska; 25 Aug. 1915; W. W. Brown.

Diagnosis. A medium sized Savannah Sparrow with stout bill, its depth at base more than half the length of the culmen; similar to *P. s. savanna* Wilson of eastern North America, but averaging slightly larger, and in autumn at least, more richly colored above and on sides of head. In spring, general coloration above with black and brown predominating, gray element reduced; lores, superciliary, wing-coverts and inner secondaries as in P. *s. sandwichensis.*

In fall, general coloration above much richer, the reddish brown tints deeper and warmer; back of neck and sides of head strongly suffused with buffy; a strong yellowish brown wash across breast and along flanks is probably characteristic of the birds in first winter (immature) plumage.

Measurements.

	Wing	Culmen	Depth of bill
4 breeding birds from Alexander Archipelago			
1 ♂ Kuiu Id. (M.C.Z.)	72.4;	10.6 ;	5.5.
3 ♀	71.3–68.9;	11.1–10.7;	5.9–5.7.
10 birds Sitka, August 13–29			
5 ♂	74.7–72.4;	11.2–10.2;	6.1–5.5.
5 ♀	71.4–69.3;	11.1– 9.4;	5.9–5.2.
Migrants			
♂ [76]	74.7–71.9 [69.8];	[—] 11 –10.2 [10.1];	[6.1] 5.9–5.5 [5.4].
♀ [72.5]	70.5–68.6 [68.5];	[11] 10.9–10.3 [10.2];	[6] 5.8–5.4 [5.1].

Breeds on islands in the Alexander Archipelago from Chichag of Island to Prince of Wales Island; also on the adjacent mainland at the Chickamin River. In migration occurring on the coast and islands from the Taku River, southward along the coast of British Columbia, Queen Charlotte Islands and Vancouver Island; western Washington to Oregon (Fort Klamath) and northern California (Tehama County) Accidental (?) at West Berkeley, California.

Grinnell (Univ. Cal. Publ. Zool., **5**, 1909, p. 227–228) records this race as arriving on Admiralty Island May 1st; Swarth (id., **7**, 1911, p. 85) found first arrivals on Kuiu Island May 3rd. It is still migrating well into May. Swarth (id., **10**, 1912, p. 56–57) found it on Vancouver Island 19 May. We have examined specimens in the Bent and Batchelder collections taken on the coast of Washington and Vancouver Island between 25 April and 11 May; a specimen in the M. C. Z. collection from Klamath, Oregon, 26 April, is the furthest south locality whence we have it on spring migration. Swarth (op. cit.) found it migrating on the Alaskan mainland at Taku River and Port Snettisham in August; his first date of arrival on Vancouver Island is 6 Sept.; we have examined specimens in the Bent collection from Pierce County Washington 10 Sept. The farthest south whence we have seen a specimen is West Berkeley, California, no. 38031 Dwight coll., taken by R. C. McGregor 9 March, 1889. (see also Grinnell, loc. cit., p. 161, 2 records of "*anthinus*" from Lower California).

Discussion. While the Savannah Sparrow of the Sitka region is here provided with a name for the first time, its peculiarities were first pointed out by Grinnell in 1909, and further discussed by Swarth in 1911, 1912 and 1922, in each case under the subspecific name of *savanna*. Grinnell, now for several years past, has referred to *anthinus* Bonaparte not only the bird of Kodiak Id, but also of the Sitka region; this same nomenclatorial and distributional view is taken by Swarth (Condor, **35**, 1933, p. 243–245); furthermore, Oberholser (Sci. Publ. Cleveland Mus. Nat. Hist., **1**, 1930, p. 109–110), would unite birds from all of Alaska, Kodiak Island and "the interior of Canada" under the name of *anthinus*. We believe that differences exist between the Kodiak Island and southeastern Alaska birds, which we will detail elsewhere in this paper under *P. s. anthinus*. We quite agree with both Grinnell and Swarth that in the Sitka region there is a distinct race of Savannah Sparrow, more nearly related to eastern *savanna* than to its geographically adjacent allies, in fact so close to *savanna* that a good well sexed series in comparable plumage, accompanied by a series of carefully taken measurements, is absolutely essential to demonstrate

the tenuous characters upon which this form rests; if this race occupied a range adjacent to that of *P. s. savanna* we certainly could not recognize it as distinct. The stout bill readily distinguishes this form from the one inhabiting Kodiak Island, the Alaskan mainland, and the mountainous interior of British Columbia. With the possible exception of the bird of Kodiak Island, we have seen no breeding specimens that could possibly be considered as intermediate between *crassus* and *anthinus;* occasional specimens from among the migrants are difficult to place, but we have not referred to *crassus* any migrant whose bill depth was not at least half the length of the culmen. We have not seen a single specimen of *P. sandwichensis* from the long stretch of coast between Prince William Sound and Cross Sound, a matter of nearly 400 miles.

Material examined. 6 ♂ 8 ♀ from the breeding range (Sitka, Kuiu Id. Clarence Straits, Ketchikan and Howkan). Migrants and winter specimens, 37, as follows: British Columbia: Queen Charlotte Ids. 1 ♂, (Dwight coll.); Vancouver Id. 5 ♂ (Batchelder coll.); Sumas 2 ♂ Chilliwack 1 ♂; Washington: Cape Disappointment 1 ♀ (Am. Mus. coll.); Tacoma 1 ♂ (Sanford coll.); Redmond 1 ♀; Pierce Co. 1 ♀; King Co. 2 ♀; Oregon: Fort Klamath 1 ♂; California: Tehama Co. 5 ♂ 1 ♀ (Mus. Vert. Zool.) Nicasio 1 ♀ 2 May 1893, (Batchelder coll.); West Berkeley, 1 ♂, (Dwight coll.).

7. Passerculus sandwichensis brooksi Bishop

Passerculus sandwichensis brooksi Bishop, Condor, **17**, 1915, p. 187 (Chilliwack, British Columbia, type in Bishop coll.)

Diagnosis. Smallest of the races of *P. sandwichensis;* bill intermediate between the stout-billed and slender-billed forms; depth of bill averaging just about one-half length of culmen. In spring general coloration nearest *nevadensis,* averaging very slightly browner, but distinctly grayer than *anthinus;* supra-orbital stripe the same depth of yellow as in *anthinus,* much deeper than in *nevadensis;* lateral crown stripes more diffuse, the edgings broader and dark centers reduced. Difficult to distinguish in winter except by its definitely smaller size.

Measurements.

	Wing	Culmen	Depth of bill
Vancouver and adjacent Islands			
3♂	71.1–67.8;	11 –10.7;	5.3–5.1.
3♀	66 –63.9;	10.2–10.1;	5.0.

	Wing	Culmen	Depth of bill
British Columbia (Sumas and Chilliwack)			
8 ♂	[71.0] 69.5–64.4 [64.2];	[10.4] 10.2– 9.6 [8.9];	[5.3] 5 –4.9.
3 ♀	65 –64 ;	10.4–10.3 ;	5.1–4.9.
Western Washington			
10 ♂	[69.9] 68.3–65.2 [64] ;	[10.4] 10.3– 9.8 [9.7];	.
5 ♀	65.2–61.3 ;	10 – 8.8 ;	5 –4.8.

Range. Breeds on Vancouver Island, the smaller islands in the Straits, and coast of southwestern British Columbia and western Washington. Partially resident, but winters along the Pacific coast to Santa Cruz Island and central Lower California.

Discussion. Although not recognized in the current A. O. U. Check-List, *brooksi* is an excellent illustration of a subspecies with admittedly slight characters, the recognition of which is justified on additional geographic and other factors. Roughly speaking it is intermediate in coloration between *anthinus* and *nevadensis.* This character alone would not entitle it to a moment's serious consideration, but in combination with this character we find that it is definitely the smallest of the Savannah Sparrows. With the exception of the slightly larger birds on Vancouver Island, the great majority of the individuals of *brooksi* are below the minimum measurements of *anthinus* and *nevadensis,* so that even winter migrants can be recognized positively. We find that these birds occupy a very definite though limited geographic area, that they differ from all the other Savannah Sparrows in being largely resident, and Major Brooks has shown that their breeding season is well advanced before the horde of northbound *anthinus* arrives from the south in spring. We are, consequently, dealing with a bird which is not a mere intermediate between *anthinus* and *nevadensis* in characters, and which is isolated geographically or ecologically from the breeding ranges of these two subspecies.

The recognition of *brooksi,* therefore, serves two useful purposes. It eliminates one perfectly definite and recognizable population, and renders easier the task of identifying and describing the abundant nontypical material of the two other races.

Material Examined

British Columbia		
Vancouver Id.	3 ♂ 1 ♀	Batchelder coll.
Lulu Id.	1 ♂ 1 ♀	Batchelder coll.
Seal Id.	1 ♂	M. C. Z.

Sumas	7♂ 2♀ 1?	M. C. Z.
Chilliwack	3♂ 1♀	M. C. Z.
Okanagan	1♀	M. C. Z.
Washington		
King Co.	8♂ 4♀	M. C. Z. and D. E. Brown coll.
Pierce Co.	1♀	Thayer coll.
Grays Harbor Co.	1♂ 1♀	D. E. Brown coll.
Ocosta	2♂	Batchelder coll.
Tacoma	1♀	Thayer coll.
Puget Sound	1♂	M. C. Z.
California		
Santa Cruz Id.	1♂ 1♀	Thayer coll.
Riverside	2♂	Batchelder and M. C. Z.
Sonoma Co.	1♂	M. C. Z.
Lower California		
Rosario	1♀	Thayer coll.

8. Passerculus sandwichensis anthinus Bonaparte

Passerculus alaudinus of authors., not of Bonaparte.

Passerculus anthinus Bonaparte, Compt. Rend. Acad. Sci. Paris, **37**, 1853, p. 920 (Kodiak Island).

Passerculus sandwichensis xanthophrys Grinnell, Condor, **3**, 1901, p. 21 (St. Paul, Kodiak Island, Alaska).

Diagnosis. A medium sized Savannah Sparrow with slender bill, its depth at base averaging less than half the length of the culmen. In spring general coloration above either with black and brown or gray and brown predominating, but whitish edgings of the scapulars always narrow, and more or less washed with gray. In fall similar to spring plumage, but coloration richer.

Measurements.

	Wing	Culmen	Depth of bill
6♂	Norton Sound region, Alaska		
	[72.4] 71.4–70.5 [70] ;	[—] 11 – 9.9 [9.5] ;	[—] 5.2–5.0 [4.6].
6♂	Nunavak Island, Alaska		
	[—] 74 –72.8 [72] ;	[10.6] 10.5–10.3 [10.25];	[5.3] 5.2–5.0 [4.9].
	(In wing length these birds would seem to approach *sandwichensis*.)		
5♂	Interior of Alaska		
	[74.5] 74.1–70.6 [69.3] ;	[11.2] 11.1–10.9 [10.7] ;	[5.2] 5.0–4.9 [—].

	Wing		Culmen		Depth of bill
4 ♂	Kenai Peninsula				
	[73.5] 73.1–72.2 [71.75];	[11]	10.6–10.3 [—]	;	[5.5] 5.0–4.4 [—].
3 ♂	Kodiak Island				
	71.3–70.5	;	11 – 9.6;	;	[6.1] 5.2–5.0 [—].
3 ♂	northern British Columbia				
	74.4–72	;	10.4– 9.8	;	5.1–4.9.
2 ♀	Norton Sound region, Alaska				
	68.3–68	;	10	;	4.8–4.6.
4 ♀	Nunavak Id.				
	69.1–66.7	;	10.7–10.5	;	5.1–4.7.
4 ♀	Interior of Alaska				
	69 –64	;	11.4–10.6	;	5.1–4.9.
4 ♀	Kenai Peninsula				
	67.7–65.7	;	10.5–10.1	;	4.9–4.4.
2 ♀	Kodiak Island				
	66.7	;	11.2–11	;	5.7–5.1.

Breeds in Alaska (except Alaska peninsula and extreme southeast), Yukon and Mackenzie, south to northern British Columbia (upper Stikine River) Skeena River (Atlin, Caribou, Lake La Hache) and southern Mackenzie (Great Slave Lake); Nunavak Island; Herschell Island (ad and yg, Mus. Nat. Hist. Univ. Iowa examined).

On *migration* occurs most numerously on the Pacific coast; and more thinly through the Rocky Mountain States east to the western half of the Great Plains; in *winter* south to Lower California, New Mexico, and Mexican Plateau, and (accidentally?) to eastern Tamaulipas.

We do not have very satisfactory data on the spring migration, but from the meagre facts at hand it would seem that its arrival in Alaska is behind its arrival in Mackenzie. Bishop (No. Am. Fauna no 19, 1900, p. 83, 84) lists a ♂ from Skagway 31 May; Dall (Trans. Chicago Acad. Sci., **1**, 1869, p. 284) records it from a number of localities, the northernmost of which is St. Michaels and says that it "arrives late, about June 1st;" 40 Mile upper Yukon, ♂, 7 May, 1898, C. L. Hall, M. C. Z. Swarth, (Univ. Cal. Publ. Zool., **24**, 1922 p. 240–241) gives its date of arrival at Junction on the Stikine River, 31 May; *tom. cit.* p. 351–352 he records it as migrating at Hazelton in the Skeena River region during the last week in May and again (*op. cit*, **30**, 1926, p. 121) records it as already present and breeding at Atlin

B.C. 28 May. We have examined a specimen in the M. C. Z. collected by Swarth, 11 May, 1909, on Prince of Wales Id., Alaska. Preble (North Amer. Fauna no. 27, 1908, p. 428) gives dates of its occurrence in the Athabaska-Mackenzie region; specimens were taken at Willow River near Fort Providence as early as 12 May; there is a bird in the M. C. Z. taken at Fort McMurray, presumably still north bound on 10 May, by H. M. Laing. A specimen in the Thayer coll. was taken by H. W. Jones 30 May along the Arctic Red River in Mackenzie and finally W. S. Brooks took a ♀ at Demarcation Point, Alaska 5 June, specimen now in M. C. Z.

In the autumn *anthinus* appears to begin its southward movement late in August, but individuals are still on the breeding grounds the middle of September. There is a ♂ in the M. C. Z. taken 31 Aug. by H. W. Marsden at Trinidad, Colo., but this must be an exceptionally early arrival; Grinnell, Dixon and Linsdale give 28 Sept. for the Lassen Peak region n California.

Material examined. 145 skins of adults, immature and juvenals, from all parts of its breeding range; 178 migrants from the Queen Charlotte Ids. and British Columbia to Lower California and from Alberta to central Mexico.

Discussion. As here restricted, the Western Savannah Sparrow of the Checklist, now called *anthinus* instead of *alaudinus*, is not quite the well-known bird it used to be to American ornithologists. The recognition of the race *crassus* eliminates one series of anomalous variants of southeastern Alaska, and the description of *oblitus*, with easily perceptible characters in any plumage, obviates the enormous range ascribed to this race by Oberholser, who was the first recent author to apply this name correctly (Sci. Publ. Cleveland Mus. Nat. Hist. **1**, 1930, p. 109). He, however, made the mistake of believing that *alaudinus* was an earlier name for *nevadensis*. To be frank, this was exactly what we would have done ourselves prior to van Rossem's note on the type of *alaudinus*, which proves to be the bird long called *bryanti*.

There are still, however, both taxonomic and systematic points calling for discussion. Swarth, for instance, has recently applied the name *anthinus* to the thick-billed bird of southeastern Alaska (Pacific Coast Avifauna, no. 22, 1934, pp. 49–50). He has an able discussion of Oberholser's review cited above, and we agree with him except in one minor technical point. It will be apparent that as the type-locality of *anthinus* is Kodiak Island, the characters of the subspecies *anthinus* will be those displayed by a definitely breeding series of

Kodiak Island birds. This we have examined. It seems to us that this series agrees perfectly with the general run of Alaska birds and is *not* the richly colored, thick-billed *crassus* of southeastern Alaska. Mr. Swarth did not happen to mention the material from Kodiak Island available to him. We have seen excellent series of breeding birds from the Prince William Sound region of Alaska and regard these also as typical *anthinus* (=*alaudinus* of Swarth).

As regards systematic points, there are certain generalizations in the way of individual variation worthy of comment. There is a rather larger degree of size variation in this race than in other western races. Certain birds from Nunivak Island are, for instance, larger than the average run. A small percentage of birds from every part of the breeding range do not have as slender bills as the norm. These birds can, however, be distinguished from *crassus* by the dull gray-brownish coloration, always lacking the rich tones of that race. Worn breeding specimens are often separable from *nevadensis* only with great difficulty, but the greater amount of pale or whitish streaking above of the latter is ordinarily apparent. Just as in the Eastern Savannah Sparrow, grayer and browner birds appear in the same series from the same place, shot in the same week or even on the same day. If this were strictly confined to late spring or breeding birds only, one might argue that the great variability of the breeding season rendered the seasonal comparability of plumages of different individuals harder to determine. But as the same thing is true of birds in fresh fall plumage, we are forced to believe that there is a certain amount of dichromatism.

There is also a geographic anomaly which deserves mention. There is a long stretch of the Alaskan coast, between Prince William Sound and just north of the Alaskan Archipelago, from whence no Savannah Sparrows have been collected or recorded. Whether these birds would show some interesting intermediate characters or not remains to be determined or at least discussed.

One final point deserves mention. In the course of identifying critically the innumerable migrants from the Pacific coast, we were much puzzled to find a small series of specimens with certain peculiar characters, which rendered them readily recognizable. Briefly they are Savannah Sparrows, which in wing length are clearly *sandwichensis*, but with an absurdly short and slender bill as in *anthinus;* in coloration either like *sandwichensis* or strongly approaching *anthinus*. It will be clear that we have here a striking and easily recognizable intermediate, the breeding ground of which is as yet unknown, but must

be somewhere in the Alaskan region, and by inference must be extremely localized. For the sake of a clear and complete record to assist further research, we list these specimens below with their measurements.

	Wing	*Culmen*	*Depth*	*Collection*
♂ Washington, Tacoma, April 29, 1914				
	76.5	10.4	5.4	Bent
♂ California, San Francisco Bay, Nov. 12, 1887				
	76.0	10.4	5.7	M. C. Z.
♂ California, Riverside, Oct. 27, 1888				
	77.5	10.1	5.0	M. C. Z.
♂ California, Tehama Co., April 22, 1908				
	76.0	10.1	5.1	Dwight
♀ California, Tehama Co., Dec. 18, 1927				
	77.0	10.4	5.7	M. C. Z.
♂ Arizona, Arlington, Nov. 13, 1918				
	75.5	10.2	5.25	Dwight
♀ New Mexico, Socorro, Jan. 11, 1899				
	76.4	10.4	5.0	M. C. Z.

9. Passerculus sandwichensis nevadensis Grinnell

Passerculus sandwichensis nevadensis Grinnell, Univ. Cal. Publ. Zool, **5**, 1910, p. 312 (Soldier Meadows, Humboldt Co. Nevada)

Passerculus sandwichensis campestris Taverner, Proc. Biol. Soc. Wash., **45**, 1932, p. 204 (near Red Deer, Alberta)

Diagnosis. A medium-sized, pale, gray Savannah Sparrow with relatively slender bill, its depth less than half the length of the culmen. Similar to *P. s. anthinus* but averaging slightly smaller; much paler above and less heavily streaked below. In spring general color above black and gray, the brown element much reduced and very often entirely absent; scapulars broadly edged with white or grayish white; yellow superciliary paler, more lemon yellow than in any of the other races already dealt with; streaks below rather narrow, brownish, never black. In autumn the dorsal plumage is overlain with a clay color caste which wears away with the approach of winter; the superciliary is creamy or very faintly tinged with pale yellow. (cf. plate, fig. 1)

Measurements.

Wing	Culmen	Depth of bill	
Humboldt Co., Nevada (topotypes)			
4♂ 72 –69.5	11.9– 9.8	5.4–4.4	M. V. Z.
5♀ 68.4–65.6	11 – 9.8	5.5–4.4	M. V. Z.
California			
2♂ 69.9–69.3	10.1–10	5.0	M. V. Z.
California			
3♀ 66 –62.4	10.7– 9.6	4.8–4.3	M. V. Z.

Range. Breeds in British Columbia east of the Cascade Range and north to the Cariboo district; Alberta north to Lake Athabasca, southeastward across Saskatchewan and Manitoba to the southern end of Lake Winnipeg; south through Washington (except western portion occupied by *brooksi*) and Oregon to northern California, Utah, and Nevada; east to the plains of eastern Colorado, South Dakota, Minnesota and (prairie section?) of southern Wisconsin. Migrates southward to winter quarters in southern California, northern Lower California, northern Mexico (specimens seen from states of Sinaloa, Coahuila, Mexico, Guerrero and Tamaulipas). We have examined a series of fifteen birds taken between 29 Sept. and 22 Oct. 1890 at Ft. Reno, Ind. Terr. by Dr. J. C. Merrill; eight of these are quite typical *nevadensis*, the other seven are variously intermediate toward *P. s. savanna*. *Nevadensis* apparently does not winter in Arizona or New Mexico, but appears to winter sparingly in southeastern Texas.

Discussion. Of all the races of typical Savannah Sparrows (in the old or popular sense), *nevadensis* is by all odds the most difficult and unsatisfactory to understand, to expound or to identify, and it is for this reason that we have put it last. The outstanding reason is the unavoidable one of geographic intermediacy. In the case of the Savannah Sparrow, there is a large area in the center or interior of the continent occupied by breeding populations of variously mixed racial characters, and a still larger area south of this breeding range, through which swarm twice a year a flood of migrants, composed of various races and numerous intermediate types. In any particular State or local area, therefore, thorough and adequate collecting will be required to solve the status of the species, and inevitably in many cases such specimens will have to be sent to one of the larger reference collections for critical determination.

We can well afford to sympathize with the difficulties of these

local students. With hundreds of specimens before us of the *nevadensis* complex, the picture presented below is the result of nearly two years studying the facts displayed by the specimens plus the critical comments and reference skins sent us by such keen collectors and students as Drs. T. S. Roberts, and J. Van Tyne, Messrs. A. M. Bailey and Philip Dumont, and for Canada by Mr. P. A. Taverner. It was these gentlemen and the Pacific Coast ornithologists who gradually amassed evidence that the picture of the A.O.U. Checklist, 3rd edition, of an eastern "Savannah Sparrow" and a paler, grayer brown, slenderer billed "Western Savannah Sparrow" required radical alteration.

The tardy recognition of *nevadensis* by eastern ornithologists is easily explained. Even today no eastern collection has an adequate series of breeding topotypes, and the convergence in characters of winter specimens of *anthinus* (formerly *alaudinus*) and *nevadensis* is often so great that an identification becomes a matter of judgment rather than positive fact. Dr. Grinnell has kindly furnished us an adequate series of breeding topotypes. The facts are that these birds are so distinct from breeding Alaskan series of *anthinus* that any school boy could tell them apart at a glance, and the difference between these two races is much more obvious than between most specimens of "western" versus "eastern" Savannah Sparrows. Our readers, therefore, should avoid the tacit assumption that the more recently described and recognized subspecies are automatically "finer splits" than the older ones. This assumption is steadily on the increase among bird-lovers in the United States, but emanates chiefly from people who never have and probably never will take the trouble to compare topotypes of any two subspecies in question. We must admit that we did not have a very high opinion of *nevadensis*, until we took this trouble ourselves.

Breeding birds from the mountains of eastern California, Utah, eastern Oregon and eastern Washington agree absolutely with Nevada topotypes. Breeding birds from the southern half of Wyoming and Idaho and western Colorado clearly indicate *nevadensis* as the breeding bird, but not the extreme gray type from Nevada. We have seen no breeding series from extreme northwestern Montana. Roughly speaking a browner tone tends to increase northward, but the working out of the details of these local populations must be left to the future. In the drier areas of the Great Plains and the eastern base of the Rockies we return once more to grayer birds. There is no doubt but that specimens from eastern British Columbia are nearer *nevadensis* than *anthinus*. Still further east topotypes of *campestris* Taverner from

Red River, Alberta, are inseparable from *nevadensis*. This is most regrettable, as Taverner's summary of racial variation in Canadian Savannah Sparrows cannot be improved upon. Elsewhere in the central Canadian provinces and southward, in the Plains and Prairie States, a welter of minor variant populations breed. Obviously gray and slender billed birds breed as far east as Lake Winnepegosis, Manitoba and Delavan, Wisconsin, intergrading northeastward with *oblitus*, eastward with *savanna*, and northward and westward with *anthinus*. Not one in ten of these birds is a reasonably close match of a Nevada topotype, but all are collectively nearer *nevadensis* than anything else, and must be referred here. We believe that Taverner is quite correct in his supposition that the boundary between *nevadensis* and the eastern races in the ecological one between the prairies and plains on the one hand, and the more northern and eastern woodlands on the other. His thesis for Canada is well endorsed by the reference specimens kindly sent us by Dr. Roberts from Minnesota. The Savannah Sparrow of the Boreal woodlands of northeastern Minnesota is clearly *oblitus;* the bird of the prairie region of the western part of the State is nearer *nevadensis* than anything else, but it is putting it mildly to say it is not typical.

Another most unsatisfactory situation in this whole area is the total lack of what may be called progressive variation. It would be quite understandable if the birds from Delavan, Wisconsin departed most widely from typical *nevadensis*, because they came from furthest east. They do not; in fact they are appreciably grayer than other breeding birds from points further west. The same situation prevails in Iowa and the Dakotas. Here and there we have small breeding series, some minutely browner, others minutely grayer, regardless of whether they are east, west, north, or south of each other. The variation between local populations is greater than the individual variation in any one series.

The worst problem of all, however, is with certain large series of breeding birds from the eastern slopes of the Rockies in Colorado and eastern Montana. Contrary to what one would normally suppose, these birds are *browner* than the non-typical Plains birds we have just been discussing. So brown are some of these birds that they might just as well be referred to *anthinus* as to *nevadensis*. While it could be argued that they are minutely nearer *nevadensis*, and this we believe ourselves, they must provisionally at least be referred here, as otherwise both *nevadensis* and *anthinus* would have widely disconnected ranges.

10. Passerculus sandwichensis brunnescens (Butler)

Ammodramus sandwichensis brunnescens Butler, Auk, **5**, 1888, p. 265 (Valley of Mexico)

Passerculus sandwichensis brunnescens, Oberholser, Sci. Publ. Cleveland Mus. Nat. Hist., **1**, no. 4, 1930, pp. 109–111 (monog., crit.)

Diagnosis. A Savannah Sparrow with a curious combination of characters; medium sized with proportionately the shortest bill, its depth more than half the length of the culmen; in breeding plumage almost exactly intermediate between *savanna* and *alaudinus* (formerly *bryanti*), entirely devoid of the gray tones so striking in *nevadensis*, its nearest geographical ally. In fresh fall plumage all suggestion of relationship to *alaudinus* is lost; closest to *savanna* and *crassus*, but even more richly colored, the gray element above absent, a richer and more tawny brown, particularly noticeable on rump, with much broader black streaking and centers to feathers of interscapulum; below, streaking heavier and blacker, with no buffy wash across chest and side of head.

Measurements.

	Wing	Culmen	Depth of Bill
13 ♂	74 –68	[11] 10.5–9.5	6.5–5.5 [5.2].
6 ♀	68.5–66.5 [65.5]	10.2–9.5	6.0–5.5.

Range. Breeds in the Boreal Zone on the tableland of Mexico and northwestern Guatemala. Breeding birds examined from Jalisco, Hidalgo, Mexico, and Puebla in Biological Survey collection; 5 nonbreeding specimens from Jalisco and Mexico (same collection). There is a good series of this bird in the British Museum, including six collected in late June by W. B. Richardson at Hacienda Chancol (11,000 ft.) on the high plateau of Huehuetenango, northwestern Guatemala (examined by L. G. in July, 1934). In addition to these specimens we have seen the alleged "type," really one of the cotypes, killed Dec. 8, 1879 in the Valley of Mexico, now in the National Museum. [Another of the cotypes listed in the original description, a specimen in the American Museum from the Valley of Mexico is really *anthinus*.] Also 1 ♀, March 14, 1932, Chilpancingo, Guerrero, in M. C. Z.

Discussion. The Mexican race of the Savannah Sparrow has had to date a brief and inglorious career. Butler's description was based on winter specimens only. As the years passed, no evidence was ever published that any Savannah Sparrow bred in Mexico, where northern

races were abundant in winter. Mr. Ridgway's treatment of the situation in 1901 in Part I of the Birds of North and Middle America defies explanation. He had before him the breeding specimens from the Biological Survey discussed above and Mr. Butler's original series of *brunnescens*. He referred all the breeding birds to *alaudinus* (at that time the composite "western" race) and all but the "type" of *brunnescens* to *alaudinus* also. The "type" he stated agreed minutely with *bryanti* from the salt marshes of San Francisco Bay, which he thereupon listed as "occasionally southward in winter to central Mexico." Needless to say we disagree so emphatically with this identification, that we would have suggested a pure *lapsus*, were not Mr. Ridgway's comments so full and clear. Thirty years again passed before *brunnescens* appeared in print, nor was any definite evidence published that a Savannah Sparrow bred in Mexico. In 1930 Oberholser (*loc. cit.*) concluded a discussion of the races of the Savannah Sparrow with a list of the valid forms, giving *brunnescens* as the breeding bird of Mexico, without any discussion, no list of specimens, or no diagnosis of characters.

One point of nomenclature emerges from the preceding discussion. The name *brunnescens* is based on a series of cotypes, comprising at least two subspecies. As a mere formality we here restrict the application of the name to that element in the original series, showing the diagnostic characters of the male shot on Dec. 8, 1879, which is marked "type" in Butler's handwriting on his original label, and which also carries a U. S. Nat. Mus. type label.

As here defined the race *brunnescens* is easily recognizable. Individual variation and wear present their usual difficulties. In worn breeding birds one extreme closely resembles certain worn eastern Savannah Sparrows in general coloration. Such birds are usually distinguishable by the blacker streaking below and the shorter bill. At the other extreme in this plumage, certain specimens in general effect above are inseparable from *anthinus*, but they are even more readily distinguishable by the less black streaking below and the deeper bill. The *palest* worn breeding *brunnescens* before us is inseparable from a very few selected dark skins of *anthinus*, but has a bill of very different proportions.

In fresh fall and winter plumage *brunnescens* is easily distinguishable from any other race. As the season advances the usual wear and fading take place. By March and April the rich brown tone above has largely (rarely completely) been lost. Such specimens, again, closely resemble in general coloration *worn breeding* specimens of *anthinus*

from Alaska, but are usually readily separable from migrant specimens of *anthinus* from the Mexican plateau.

11. Passerculus sandwichensis alaudinus Bonaparte

Passerculus alaudinus Bonaparte, Compt. Rend., **37**, 1853, p. 918 (California), but not of American authors.

Passerculus sandwichensis bryanti Ridgway, Proc. U. S. Nat. Mus., **8**, 1885, p. 354.

Diagnosis. A rather small Savannah Sparrow, intermediate in size between *savanna* and *brooksi*, with the bill intermediate in proportions, in some specimens the depth considerably more than half the length of the culmen, in others appreciably less; very different from the adjacent breeding or migrant races in being very much darker and browner, with a great development of black streaking above, and much more heavily streaked with black (not brownish or blackish brown) below.

Measurements.

	Wing	Culmen	Depth of bill
7 ♂	San Francisco Bay Region		
	[69.4] 67.9–63.6 [61.8];	[11.2] 10.7–10.0 [9.75];	5.4–4.9.
10 ♂	Ventura County		
	67.8–65.0 ;	[12.0] 11.7–10.6 [10.0];	5.8–5.2.

Range. Resident in the coastal salt marshes from San Francisco Bay to Ventura County, California.

Discussion. This local coastal race, better known as *bryanti* to American students, must now be known as *alaudinus* Bonaparte. Mr. A. J. van Rossem examined the type in the Paris Museum and discovered that the name had been misapplied for eighty years. Quite independently, we sent a pair of every possible California race to Mr. Berlioz with the request that he compare the type of *alaudinus* Bonaparte with them. His letter makes it clear that he regarded the type as nearer *bryanti* than anything else.

This local race is really a step further in darkness above than *brunnescens* of Mexico, but is even more heavily streaked with black below, and the brown element above is a darker shade. The first fall plumage is noticeably browner above, the chest and sides strongly tinged with brownish buff and is consequently quite distinctive. Certain spring specimens of *oblitus* approach *bryanti* in general color effect

quite closely, but needless to say these specimens are not in seasonably comparable plumages and the measurements and bill proportions are quite different.

The series from Ventura County is a distinct approach in the heavier streaking below to *beldingi*, and the larger bill of these birds is a definite *beldingi* character. These birds make it quite impossible to maintain *beldingi* as a distinct species. Individuals from colonies in San Mateo and Los Angeles Counties are also obvious intermediates.

12. Passerculus sandwichensis beldingi Ridgway

Passerculus beldingi Ridgway, Proc. U. S. Nat. Mus., **7**, 1885, p. 516 (San Diego, California)

Diagnosis. Similar to *alaudinus*, but more heavily and extensively streaked with black below; upperparts more olivaceous, less markedly streaked with brown and black; bill distinctly larger.

Range. Salt marshes of southern California and northern Lower California from Ventura County to San Quentin Bay.

Discussion. In recent studies of the *rostratus* group, the status of *beldingi* has come up for discussion. Huey (Aug. 1930) in announcing the discovery of *anulus*, proved conclusively that it was a perfect connecting link between *beldingi* and the *rostratus* group, and suggested that the specific distinctness of *bryanti* and *beldingi* would prove untenable. Van Rossem (Nov., 1930) did not hesitate to be more definite, and reduced all the salt marsh Sparrows from central California southward to races of *sandwichensis*. We subscribe wholeheartedly to this proposition. Just as van Rossem says, both *bryanti* and *beldingi* are very variable, and while geographically isolated, intergrade by individual variation in the overlapping of characters. We here point out, however, that Bishop (Condor, **17**, 1915, p. 187) long ago suggested that *beldingi* and *bryanti* were conspecific, and alleged exactly the evidence recently advanced for so doing. Just why his remarks were ignored for over two decades is not clear to us.

REMARKS ON THE *ROSTRATUS* GROUP

As explained in the introduction to this paper, we have no intention of monographing the "Large-billed" Sparrows in the same detail as the "Savannah" Sparrows. In recent years the Pacific coast ornithologists have secured most important series of critical specimens, have

discovered the breeding grounds of all but one of the proposed forms, and have finally settled many systematic and geographical points. There are still one or two controversial points outstanding. As usual this proves to be due to the lack of specimens from critical points at the proper season of the year. This material being non-existent, there was no point in reassembling for the third time in five years, the available specimens in American collections, as we could have made no further progress.

We here make special acknowledgement of assistance from Mr. Laurence M. Huey of the San Diego Museum. He borrowed the entire M. C. Z. collection of the *rostratus* group, and has returned it with interesting comments on the more important specimens. He was also kind enough to send us definitely breeding series of most of the described races. We have a most interesting letter from him discussing the problems which still await final solution. As a matter of complete record, therefore, we give a brief summary of the races of the *rostratus* group and the research work which must still be done before finality is obtained. For diagnoses, critical comparisons, measurements and ranges, readers should consult the following papers:—

1. Oberholser, Ohio Journ. of Science, **19**, 1919, no. 6.
2. Huey, Trans. San Diego Soc. Nat. Hist., **6**, Aug. 1930, no. 10.
3. van Rossem, loc. cit., Nov. 1930, no. 14.

The following facts would seem to be definitely and finally proved and agreed to by everyone.

13. *Passerculus sandwichensis anulus* Huey, *loc. cit.*, p. 204. A distinct subspecies, connecting *beldingi* with *P. rostratus halophilus* (McGregor) of the current A.O.U. Checklist, breeding at Scammon Lagoon, Lower California, and not as yet detected elsewhere as a migrant.

14. *Passerculus sandwichensis halophilus* (McGregor), Auk, **15**, 1898, p. 265. Another distinct race, breeding at Abreojos Point, Lower California, south to Magdalena Bay, and straggling south in winter to the Cape Region.

15. *Passerculus sandwichensis sanctorum* Ridgway, Proc. U. S. Nat. Mus., **5**, 1883, p. 538. This name is here used provisionally, as it is based on the breeding birds of San Benito Island, which population all students agree to represent another perfectly tenable race. Whether this subspecies should be called *sanctorum* or *guttatus* Lawrence is not, however, finally settled. Oberholser alone has had the two types before him and regarded them as identical. Messrs. van Rossem and Huey do not agree, but disagree in their understanding of *guttatus*.

16. *Passerculus sandwichensis rostratus* (Cassin). There is no dispute about this subspecies. All students agree on its distinctness, characters, and range. It breeds in the delta of the Colorado River in Lower California and Sonora, and migrates to southern California, the whole of Lower California, and southward on the Mexican mainland to Guaymas.

17. *Passerculus sandwichensis atratus* van Rossem, *loc. cit.*, p. 218. This name is here used provisionally, as it is based on the breeding bird of the coast of central and southern Sonora.

To sum up, those people who have seen proper series of breeding birds agree that there are five subspecies, with easily perceptible characters, which breed in the five areas outlined above. The first difficulty is the correlation of migrant birds in fresh winter plumage with these five races in the radically different breeding plumage. In the past this has been done on an inferential basis. It will be apparent that the opinion of anyone in the past in referring certain winter specimens to one of the *three possible races known to him* must be rechecked when there are now five. This is particularly true in birds with such peculiar habits of migration; *rostratus*, for instance, occurs as a migrant in the breeding areas of all the other four races, and migrants from the Cape Region are suspected to belong to three and possibly four subspecies. The only way of disposing of the inferential basis of the past is to visit the breeding grounds of the various subspecies at some other period of the year and collect specimens in fresh winter plumage of resident individuals just prior to their migration. In the case of *anulus* and *atratus* nothing but worn breeding material exists. There are migrant *halophilus* records from the Cape and Todos Santos, but these identifications were made prior to the discovery of *anulus*, and should obviously be rechecked.

This discussion should help make clear the outstanding problem still remaining in the *rostratus* group, namely the identity of *guttatus* Lawrence, 1867, the type, a migrant from the Cape. It will be obvious that unless *guttatus* is a synonym of *rostratus*, some one of the other four races must be called *guttatus*. Lack of material making a final settlement of this proposition impossible, we give below the three suggestions current as to the identity of *guttatus*, the arguments pro and ante as we see them, and conclude with our own suggestions as to just what is required for final proof.

1. *Guttatus* is an earlier name for *sanctorum*. Oberholser, 1919. Based on the comparison of the two types, and the *inference* that *guttatus* was the winter plumage of *sanctorum*. It is no reflection on Dr.

Oberholser to suggest that this identification should be rechecked, with the discovery of two additional dark races, the winter plumage of which is unknown.

2. *Guttatus* is the dark extreme of variation of *rostratus*. van Rossem, 1930. This interpretation was based on visiting the breeding grounds of *rostratus* in the breeding season of 1925, and collecting reddish, and grayish specimens and a "small, dark colored bird with the back heavily streaked with blackish." Winter series from southern California showed a very variable series of reddish, grayish and blackish birds, the last currently referred to "*guttatus*." Mr. van Rossem argued that the three types of winter specimens could now be correlated with the three types of breeding plumage on the breeding grounds and that ergo, *guttatus* was a synonym of *rostratus*. In 1927 he examined the type of *guttatus* in Washington and regarded it as representing the "dark, slender-billed extreme of the birds found in winter in southern California." We comment on this below.

3. *Guttatus* is the winter plumage of *atratus*. This theory was communicated to us by Mr. Huey, 1933, *in litt.*, after examining the M. C. Z. series of the *rostratus* group. Our collection contains four specimens pertinent in this connection, winter migrants from the Cape in the Brewster Collection. They are the darkest specimens in winter plumage in the Museum: they were compared by Mr. Brewster directly with the type of *guttatus*, and the *very darkest of all*, no. 215745, is labelled in his handwriting "practically identical with the type of *guttatus*." We have seen various specimens representing the dark, slender-billed extremes found on the California coast in winter, currently labelled "*guttatus*," and can only say that no. 215745 is unquestionably another subspecies.

When the differences between the breeding and winter plumage of those subspecies *where it is positively known* are examined, *by analogy* the four dark birds in the Brewster Collection might indeed be the unknown winter plumage of *atratus*. The objection to this theory is that the type of *guttatus* is unquestionably a slenderer-billed bird than *rostratus*, while *atratus* is even larger billed.

It should be very evident that the final identification of the type of *guttatus* cannot be made until (1) the winter plumages of all five subspecies are positively known and (2) representative series of all five races in winter plumage must be directly compared simultaneously with the type of *guttatus*. Until this can be done, the identity of *guttatus* will be a matter of argument and inference rather than fact.

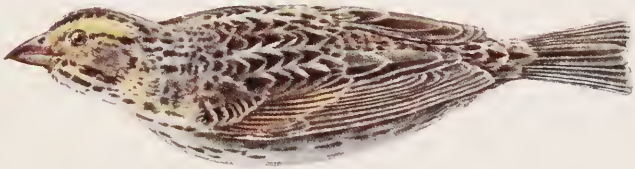
	MCZ	Thayer	Batch-elder	Bent	Ken-nard	AMNH	Biol. Surv.	U. S. Nat. Mus.	Nat. Mus. Canada	M.V.Z.	Calif. Acad. Sci.	Univ. Minn.	Colo. Mus.	Chic. Acad. Sci.	Univ. Mich.	Univ. Iowa	Ohio State Mus.	D. E. Brown
savanna (555)	238	110	92	21	12	20	..	..	12	..	..	..	11	10	14	..	15	..
oblitus (152)	28	6	27	2	..	5	..	..	36	..	..	2	6	28	1	7	4	..
labradorius (152)	54	12	67	4	..	14	..	..	..	..	..	..	..	..	1	..	..	..
princeps (199)	67	57	42	14	10	..	..	..	..	..	..	..	..	..	..	..	..	..
sandwichensis (57)	13	3	3	12	..	17	..	9	..	..	..	..	..	..	..	..	..	..
crassus (44)	8	14	6	5	..	3	..	..	..	8	..	..	..	..	..	..	..	..
anthinus (354)	109	50	39	21	10	47	41	5	2	14	10	..	2	3	..	7	..	4
nevadensis (412)	125	31	69	13	3	30	..	..	2	18	..	34	..	5	3	12	..	3
brooksi (57)	30	4	9	9	..	..	..	..	..	..	..	..	..	..	..	..	..	5
brunnescens 23	1	..	..	..	..	..	21	1	..	..	..	..	..	..	..	..	..	..
bryanti (140)	32	27	73	3	4	San Diego Mus.		..	..	..	..	..	..	1	..	..	..	..
beldingi (142)	59	20	48	10	5	..	27	..	..	..	..	..	..	..	..	..	..	..
rostratus (186)	105	44	15	8	6	6	..	..	..	..	..	..	..	..	2	..	..	..
"guttatus" (8)	5	1	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..
sanctorum (17)	4	13	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
halophilus (8)	1	1	..	..	..	6	..	..	..	..	..	..	..	..	..	..	..	..
anulus (9)	2	..	..	..	..	7	..	..	..	..	..	..	..	..	..	..	..	..
atratus (10)	2	..	..	..	..	8	..	..	..	..	..	..	..	..	..	..	..	..
Total 2516	883	393	490	104	50	136	62	15	52	40	10	36	19	47	21	26	19	12

EXPLANATION OF PLATE

EXPLANATION OF PLATE

Figs. 1 and 1a. *Passerculus sandwichensis nevadensis.*
Figs. 2 and 2a. *Passerculus sandwichensis savanna.*
Figs. 3 and 3a. *Passerculus sandwichensis labradorius.*

1



2

3

1a

2a

3a

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
Vol. LXXX, No. 14

MCZ-C

ORIGIN OF THE LAND AND FRESHWATER MOLLUSK FAUNA OF THE BAHAMAS, WITH A LIST OF THE SPECIES OCCURRING ON CAT AND LITTLE SAN SALVADOR ISLANDS

By William J. Clench

With Three Plates

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
June, 1938

Museum of Comparative Zoology
JUN 13 1938
LIBRARY

No. 14. — *Origin of the Land and Freshwater Mollusk Fauna of the Bahamas, with a List of the Species Occurring on Cat and Little San Salvador Islands* [1]

By William J. Clench

INTRODUCTION

The conclusions reached in this present study are based almost entirely upon the land and freshwater mollusks of the Bahama archipelago. Material from these islands at my disposal for study dates from Henry Bryant, Thomas Krebs, Sir Rawson W. Rawson, and others who had collected in the Bahamas about 75 years ago.

In addition to this early material, there have been studied the shells collected by several expeditions to these islands by members or associates of this museum, as well as specimens kindly contributed by L. Plate, H. A. Pilsbry and Don Waters. The following list includes only those expeditions in which we have been directly concerned.

Between 1883 and 1915, C. J. Maynard of West Newton, Mass., paid several visits to the Bahamas, mainly in quest of the genus *Cerion*. His entire collection was purchased jointly by the United States National Museum and the Museum of Comparative Zoölogy and equally divided between them. Maynard explored the islands of Andros, New Providence, the Berry Islands, cays between New Providence and Eleuthera, Rum, Long, Great Inagua, and the long series of islands composing the Exuma chain.

Alexander Agassiz, during the "Wild Duck" expedition in 1893, obtained a few land mollusks in the Bahamas. These were reported upon by W. H. Dall (1894, pp. 113–124). Dall also included in this report the records of shells collected by the "Albatross" and those collected by J. J. Brown on Watling Island. Collections by Mr. Agassiz came from New Providence, Eleuthera, and Watling Islands, Gun Cay, Bimini group, Great Ragged and Flamingo Cays in the Ragged Island group.

In 1904, Glover Allen, Thomas Barbour, and Owen Bryant visited the islands on the Little Bahama Bank and obtained a large collection of shells, which were subsequently reported upon by William H. Dall (1905). A portion of this collection was retained for the National Museum, the remainder returned to this institution. They visited New Providence, Grand Bahama, Little and Great Abaco islands.

[1] Lists of the Echinoderms, Reptiles and Amphibians collected are given at the end of this report.

During January and March, 1932, Mr. A. V. Armour's yacht, the "Utowana," visited these islands, which were included in a more extended trip to other parts of the West Indies and the coast of South America. Dr. David Fairchild collected a series of mollusks on New Providence, Cat, Conception, Rum, Mariguana and Great Inagua islands.

In January and February, 1933, the "Utowana" stopped at New Providence, Watlings, Crooked, Fortune, Mariguana, the Plana cays, Great and Little Inagua islands. Thomas Barbour, David Fairchild, and J. C. Greenway, Jr., collected a fine series of shells from all of these stations.

Again in February and March, 1934, the "Utowana" visited New Providence, Grand Bahama, Great Abaco, Eleuthera, Cat, Conception, Watling, Rum, Long, Mariguana, Crooked, Atwoods (Samana), Mira Por Vos and Great Inagua islands. As in the past trip, Thomas Barbour and J. C. Greenway, Jr. were responsible for the scientific collections obtained. On these expeditions the mollusks collected were purely incidental to other interests, but both Dr. Barbour and Mr. Greenway sacrificed much of their limited time to benefit their colleagues by collecting material for departments other than their own.

During July and August, 1935, the writer, accompanied by H. D. Russell and J. H. Huntington, visited New Providence, Cat and Little San Salvador islands. The collections made on the latter two islands are reported upon in this paper.

Early in April, 1936, I joined J. C. Greenway, Jr. and his brother, Gilbert, at Nassau, and in the latter's seaplane visited Grand Bahama, Mores, Little and Great Abaco islands. Late in April and through most of May, I collected the central and south central part of Eleuthera and on the south coast of New Providence. Prior to my joining the expedition, J. C. Greenway, Jr. and his brother had visited many of the southeastern islands during February and March by plane. The complete list of stations and the collectors are as follows:

Great Inagua, Little Inagua, Caicos and Turks Islands (J. C. and Gilbert Greenway). Southern Andros Island (J. C. Greenway, Jr.). Grand Bahama, Mores, Little and Great Abaco Islands (W. J. Clench, J. C. and Gilbert Greenway). Eleuthera Island (W. J. Clench). New Providence (W. J. Clench and J. C. Greenway, Jr.).

During July and August, 1936, H. D. Russell, accompanied by R. A. McLean, J. H. Huntington, and Richard Foster, visited New Providence and Long Islands. A very extensive collection was made on this latter island, the first expedition to do any systematic work.

Emanuel Williams, a native of Cat Island, was sent to Mariguana during December, 1936. His material from many new areas on this island supplements the "Utowana" collections.

Notes and descriptions of the new forms obtained by the several "Utowana" expeditions have appeared (Clench, 1933; 1934). A list of the land mollusks collected by Williams on Mariguana has also been published (Clench, 1937) as well as a short account of the trip in 1936 to the southeastern group of islands and those on the Little Bahama Bank (Greenway, 1938).

The above is given, not only to complete the records, but also to indicate the areas covered in part, at least, for mollusks. Little area now remains for any extensive work, two exceptions being Acklin Island on the Crooked Island Bank and the chain of islands composing the Ragged Island group. Certain of the few small islands on the Cay Sal Bank have recently been explored by Paul Bartsch of the National Museum, but the results of this expedition are as yet unpublished.

About 300 species and subspecies of land and freshwater shells are now known from these islands. This number does not include many of Maynard's forms of *Cerion* which will eventually be synonymised when studies are completed for the several remaining islands. The various expeditions mentioned above collected over 200,000 specimens which have been used in the present study.

For a great deal of general information on the Bahamas, reference should be made to "The Bahama Islands" (Geographical Soc. of Baltimore, edited by G. B. Shattuck, 1905, pp. 32+630, 93 plates, The MacMillan Co., New York). This publication not only embodies the results of an extended exploring and collecting trip to these islands in 1903, but also contains a summation, much of it in detail, of the published record concerning the zoology, botany, history, geology, etc., of this archipelago.

Origin of the Bahama Fauna

The several postulates and theories relative to the geologic history of the Bahamas need not concern us here if the thesis is accepted that these islands were completely submerged during the Pliocene and [early?] Pleistocene (Schuchert, 1935, map 16) and that the present fauna and flora has arrived by fortuitous means since that time.

Whether or not the present Bahamas had their origin in the Pliocene or Pleistocene is impossible to say. There is no evidence of the existence of fossil soils such as those found in the Bermudas. According to

Sayles (1931, pp. 449–456) the Bermudas have passed through several stages, climatic as well as change in area, during the Pleistocene. The evidence is based upon fossil soils interbedded between masses of eolianite. However, other than at the "Queen's Staircase" in Nassau, there are no deep road cuts through the lithified dunes in the Bahamas. Such cuts in the Bermudas have brought to light many of these fossil soils. At the "Queen's Staircase," Cerions are to be found in definite layers, many feet below the present dune surface. The matrix in which they are imbedded is a somewhat friable calcareous sand and the layers follow rather closely the present contour of the dune. As Cerions will exist on very scant vegetation, even that growing on loose sand, the layers mentioned above may have formed during an active rather than a specific period of rest in dune formation.[1]

We do not hold that the Bahama foreland was never connected with the islands on the south, but since its last disconnection, it has been submerged below sea level, and at no time since its elevation has this archipelago been connected to any other land area. In our opinion, the evidence based upon the occurrence and present distribution of certain land snail genera and species supports this view. Simpson (1894, p. 424) held this theory, based upon the evidence of the land mollusks. Our own conclusions are based upon far more material. Schuchert accepts this belief upon the work of Simpson and upon the botanical evidence brought together by Harshberger and others (*ibid.* p. 539).

T. Bland (1873, pp. 318–319) indicated the relationship of several Bahama species with those of Cuba and Haiti [Hispaniola]. His conclusion, drawn upon the limited number of species then known from these islands, was that the species occupying the Great Bahama Bank were closely allied with those of Cuba and the species of the easterly islands (Crooked Island group to the Caicos Islands) were affiliated with species of Haiti. He supposed upon this evidence that a connection had existed between the Great Bahama Bank and Cuba and one between the easterly islands and Haiti. The differences between these two island areas, though marked, is not nearly so exact as was thought by Bland. At that time almost nothing was known about the mollusk fauna of Long Island. This island, though on the Great Bahama Bank, possesses as many species and species groups in common with the islands to the southeast as it does with other islands on the same bank. His

[1] Such a condition is to be seen on the eastern side of Eleuthera, near Governor's Harbour. A small series of irregular dunes appeared active, to judge by the exposed root systems of the small scrub palms. Live Cerions were plentiful and dead shells existed in considerable numbers scattered over the sand.

data, however, are just as important for our theory, that the relationships in general of the Bahama mollusk fauna are due to island proximity and that they are in the paths of many hurricanes which cross the larger islands of Cuba and Hispaniola before reaching the Bahamas.

It is to be borne in mind that much of the Bahama archipelago is somewhat arid in nature. This is probably due to the general physiographic conditions of the islands rather than to climatic factors, as the poor water holding capacity of the soil, the large exposures of aeolian rock and the present day practice of burning, produce conditions similar to those found in regions of far less rainfall.[1] For this reason, many species could not maintain themselves in the Bahamas, no matter what method was open for their arrival.

During the Pleistocene, when the eustatic level of the ocean was much lower owing to the impounded waters as ice on the polar caps, the Bahamas emerged, forming much larger islands than now exist.

Daly holds, in his glacial control theory (1935, p. 47), that the greatest eustatic change lowered the present level about 75 meters or approximately 250 feet. A reduction of oceanic waters of this depth would have removed the ocean from most of the present Great and Little Bahama Banks. As a consequence, all of the islands on each bank would then have formed large single islands, the limits of these Pleistocene islands being close to the present 60-foot contour of the banks as they are today. Approximately at this contour the slopes change to a precipitous gradient leading to the profound depths of the surrounding seas. A positive eustatic change from this low ocean level would gradually fragment these larger islands into smaller land units and eventually reach the conditions as they now are. Of course, subsequent erosion and corrosion has further decreased the size of these islands, particularly on the inner or lee sides.[2] It was presumably at this low eustatic level that the dunes were produced that now form the present hills of the larger, easterly islands. Certainly no sand exists today on Cat Island in such sufficient quantities that could form the present hills that characterize this island. The Exuma chain of islands is apparently a fragment of what had once been the dunes fronting the Great Bahama Bank (island) along Exuma Sound. It is of interest to

[1] There is considerable yearly variation in the rainfall though the average appears to be about 50 inches (Nassau). Of this amount, four-fifths occurs between May and October (Shattuck, 1905, p. 117). However, in certain areas, notably Gt. Inagua and the Turks Islands, the rainfall is very slight so little over most of these latter islands that salt manufacture is possible by the evaporation process.

[2] At Governor's Harbour, Eleuthera Island, a mass of rock consisting of several hundred tons was broken off the sea cliff during the 1926 hurricane; other masses were seen of similar and lesser size, broken away during recent storms.

note that the islands possessing the highest hills (Eleuthera, Cat and Long Islands) have the most extensive shallow seas on the leeward sides, the only exceptions being Andros and Grand Bahama Islands which are comparatively low. The explanation for the low altitude of these latter islands is that during the period when the large areas of the present banks were exposed land, Andros being behind or in the lee of the eastern part of the Great Bahama Bank Island, lost the necessary wind velocity to form high dunes. Grand Bahama Island (elevation under 25 feet) on the Little Bahama Bank runs in an easterly-westerly direction and is in the lee of Great Abaco, which possesses hills upward of 100 feet. As the largest dunes form on the windward sides of land areas, the lithified dunes on the outer and windward islands can be explained in this manner, but they were formed only during the time when these islands were very much larger. Small lithified dunes that had their present base under the ocean level as it now exists, were noted at West End, Grand Bahama Island, indicating their origin at a time when the ocean level was lower.

As the ocean level rose, the extensive sand flats were gradually covered and the source of the raw material for dune formation was eventually cut off entirely, the process now being one of erosion and corrosion or only a very slight building on the easterly shores. As mentioned elsewhere there is evidence of some new rock being formed, but at most it seems to be limited and local.

A few of the present species of land mollusks probably arrived in the Bahamas at the time the larger islands existed and normal dispersal took place before the islands became fragmented. Specimens of *Hemitrochus varians* were found four feet below the surface of the aeolian rock on Eleuthera in a road cut at an elevation of more than 100 feet, and Cerions are to be seen in abundance more than 25 feet below the surface of a hill in the cut at the "Queen's Staircase" in Nassau. Both of these cases would indicate that these genera at least had reached the Bahamas during the dynamic period of dune formation.

All of the fossil land shells so far recorded from the Bahamas are very similar to recent forms, and it is questioned whether several of these are really different from present day species. At best, they would date only from the period of dune formation, those occurring in the coastal limestone may be of recent origin.

My belief in the drift origin of the mollusk fauna is based on the following points:

1. Occurrence in the Bahamas of several genera that also occur on

the lower keys of Florida and the Bermudas, of undoubted West Indian origin.

2. Possible rafting from Cuba and Central America by the Gulf Stream.

3. Hurricanes and the regular and irregular distribution of certain species and genera.

4. No endemic genera.

5. Wide distribution of many species.

1. *Genera common to the keys of Lower Florida and the Bahamas.*

There is a marked ecological similarity between many of the Florida keys and the Bahama Islands. This is an important factor in the argument, as genera that have managed to reach one region by fortuitous means could also reach the other, if the same way were open to their dispersal, and conditions in both areas were favorable for their maintenance upon arrival.

There appears to be no geological evidence of any land connection between Cuba and Florida, certainly since the lower portion of the Florida peninsula rose above sea level, yet several molluscan genera of undoubted West Indian origin are now known to occur on nearly all of the lower Florida keys. Such Cuban genera as *Urocoptis, Chondropoma, Lucidella, Macrocceramus, Liguus,* and a few others are to be found on many of these keys between Miami and Key West. *Oxystyla* of the Florida Keys, is of Central American origin and *Drymaeus multilineatus* is a species known to occur in Yucatan and in Central America. All of these forms could have reached Florida by means other than any land connection.

Hemitrochus definitely and *Cerion* possibly of the Florida Keys are of Bahama origin. *Hemitrochus varians* Mke., the only species of this genus in Florida, occurs throughout most of the Bahamas. According to Pilsbry (1902, p. 215) *Cerion incanum* Binn. of the Florida Keys occurs also on Gun Key of the Bimini group of islands in the Bahamas. However, this latter species could have reached the Bahamas from Florida just as well. A closely related form, *C. sagraianum* (Pfr.), is found on certain islands off the northern Matanzas coast of Cuba; consequently derivatives of this form may have reached both Florida and the Bahamas independently from this area. It is to be remembered that the Bimini islands are probably only a fragment of a larger island or island group that fronted the western edge of the Great Bahama Bank and Gun Key is the remaining locality for a species that probably occupied a much wider area. A few species of *Cerion* in the Bahamas are exceedingly close in their relationships to *C. incanum.*

A Helicinid, *Lucidella tantilla* Pils., possibly reached Florida from Cuba, and then was carried to the Bahamas, as it only occurs in this latter region in the northwestern portion of the archipelago. In Florida it occurs on the southern keys and up the East coast as far as Palm Beach.

It seems to us that if such genera have managed to survive mechanical transport into one region, the same agencies could be responsible for their transport into others, particularly when the distance between the northern Antilles and the Bahamas is no greater.

It is quite possible of course that other Bahama species *may* have reached Florida, but have been unable to survive continental competition. It is of considerable interest to note that neither *Cerion incanum* nor *Hemitrochus varians* has been collected on the mainland of the Florida peninsula but only on the lower keys from Miami south. There is no definite answer to this distributional problem, but it is possible that the lack of certain enemies, maybe mammalian, that do not range over these small islands, make it possible for these mollusks to exist. The distribution of these mollusks over most of the lower keys is too extensive not to have included portions of the mainland unless some sort of eliminating factor is responsible for their non-occurrence.

The above case may possibly be a parallel to the situation existing in the bird fauna of Cozumel Island off the coast of Yucatan. According to Griscom (1926, p. 8) there are several species of West Indian Birds on this small island not known to occur on the adjacent mainland of Mexico. This has given rise to the belief that Cozumel Island was connected with Cuba during rather recent times. However, a survey of this island by Richards (1937, pp. 249–262) for land and freshwater mollusks shows unmistakable evidence of purely Central American affinities. Twenty-two species of mollusks were obtained and, of these, four were new though closely related to forms occurring on the mainland, fifteen were identical to mainland forms and three were wide ranging species known from many localities on the Continent and West Indies. It would appear then, that the birds may represent migrational or accidental stock that have been able to survive on this coastal island but not on the highly competitive area of the mainland.

2. *Rafting.* The Gulf Stream is a possible factor in aiding certain forms to reach these islands. The genus *Schasocheila* (Helicinidae) is only known to occur in Central America and in the northwest Bahamas. In this latter region it is only found on the islands of the Little Bahama Banks, Andros, New Providence and Eleuthera. The western sides of both these banks are washed by the margin of this current. It is a

ground form, generally found about the roots of grass and other vegetation and as such would be subject to transport by floating debris, washed out by rivers during heavy rains. (*Oxystyla* and *Drymaeus multilineatus* in Lower Florida are forms that may have reached Florida in this way). Inter-island dispersal may have since been by hurricanes, or normal distribution took place before these islands became fragmented. Other species occurring in the Bahamas may have arrived in this same manner, but as they are of undoubted Cuban and Hispaniolan origin the method of transport cannot be differentiated from other means.

Both sides of the possibility of animal distribution by rafting have been considered in detail by Matthew (1915, p. 206–209) Barbour (1916, p. 1) and Hesse, Allee and Schmidt (1937, p. 56–71).

3. *Hurricanes.* Dispersal by means of these cyclonic storms in the Bahamas is probably our strongest argument. The very mixture of many species and even the regularity of others appears to offer no other solution.

An analysis of the hurricane charts published in Shattuck's report covers a period of 25 years from 1878 to 1903. A little over 100 hurricanes have occurred during this time, and of that number, 28 have passed over the Bahamas.[1] Of the 28 hurricanes, 8 have passed over Cuba, 9 have passed over Hispaniola and 1 over Florida before reaching the Bahamas. The remaining 10 had their origin in the Bahamas or on the Atlantic Ocean to the east and southeast. This is an approximate average of one storm a year.

Actual observation of transport by these storms is of course lacking, but there is an abundance of evidence of their destruction and carrying power during the several hurricanes that have passed over Florida, Cuba, Hispaniola and elsewhere in this region during the past few years. Certainly, small objects such as snails, insects, spiders and even birds and bats could be transported by these storms. Land mollusks particularly would be subject to such means of dispersal, as many species of *Cerion, Hemitrochus, Plagioptycha* and others find concealment under and in the curled and twisted dead palm fronds and on many other types of debris subject to wind movement. Such means would explain the erratic and anomalous distribution of species, particularly among the *Urocoptidae, Helicinidae* and certain races of *Cerion.*

McAtee (1917, p. 217) reports from many sources a surprising num-

[1] A 50 mile radius from the storm center or "eye" has been used for the above number. Many more storms could be added that have caused hurricane conditions in these islands.

ber of instances of organic matter being "showered" down. These records include numerous references of invertebrate and vertebrate animals that have been wind borne and deposited over areas considerably removed from their original source. These appear to be mainly the results of cyclones.

Small cyclonic storms, though not abundant, do occur in the Bahamas. Though they are usually limited to narrow paths, the dispersal factor may be quite important, as the ascending currents may well carry small objects to a considerable altitude, to be scattered later over a much wider territory when the wind velocity has lessened.

Many species and varieties of land mollusks are more or less regularly disposed over the southeastern groups of islands, namely: Mariguana, Inaguas, Crooked, Turks and Caicos groups. These islands are all surrounded by very deep water, and their present fauna certainly post dates the period when these islands were connected, if such a connection ever did exist. A few of these species and species groups even extend northwest to Long Island, which is the first and nearest to these southeastern islands of the several islands on the Great Bahama Bank. These species have not as yet managed to spread beyond this point. If any sort of land connection existed between all of these islands, the distribution should be far more even. Land shell distribution throughout this archipelago indicates a relationship only on the basis of island proximity and not on a possible geologic history of island associations and connections as one would expect.

Another case in question is that of *Lucidella tantilla* Pils. which has been found only on the islands of the Little Bahama Bank and the Bimini group. The identical species occurs only along the coast of Florida from the lower keys north to a point opposite these islands. Strikingly enough, these islands of the Bahamas are in the direct path of many of the hurricanes that first pass over Florida, their trend from southern Florida is generally in a northeasterly direction. Careful search for this *Lucidella* has failed to locate it on any other of the Bahama Islands. The species is less than 3mm. in size and is found on the forest floor on and under dead leaves.

Differences and similarities generally in the snail fauna of the several islands on the Great Bahama Bank are no greater on the whole than the differences between the fauna of these islands and the several isolated islands to the southeast.

It is usually held that the degree of difference between the faunas of separate land elements is more or less correlated with the length of time of such a separation. Upon this assumption, one would expect

the faunas of the Crooked Island Group, Watling, Rum, the Inaguas, etc., to show greater differences between themselves and between the islands of the Great Bahama Bank than the existing differences in the fauna between Cat, Long, and Eleuthera Islands, which are all closely associated on the Great Bahama Bank. The first group of islands are all separated by depths exceeding 850 fathoms, the latter group of islands are separated by depths that nowhere exceed 20 fathoms, yet the snail fauna of Long Island is closer in most of its relationships with the fauna of the islands in the Crooked Island group than its fauna is with New Providence, an island on the same bank. In the former case, depths of 1182 fathoms exist between Long Island and the Crooked Island group, and depths of less than 5 fathoms exist between Long Island and New Providence. It would appear to be a difference of distance and the factors of chance in the mechanical distribution or dispersal of the fauna. In the first case, Long Island is separated from the Crooked Island group by 30 miles of open sea and separated from New Providence by a distance of 160 miles.

4. *No Endemic Genera in the Bahamas.* It would appear that if the fauna of the Bahamas had arrived before the Pleistocene, at least a limited number of endemic genera would occur, similar to the case of *Poecilozonites* in the Bermudas. All genera and but one subgenus now known to occur in the Bahamas, occur elsewhere in Cuba, Hispaniola, Florida, etc., and even many species are identical to those of these places. Endemic species are also closely related to those in Cuba and Hispaniola, particularly to forms occurring on the north coast of Cuba.

5. *Wide distribution of many species.* Many of the common species exhibit a very wide distribution among the islands of the Great and Little Bahama Banks and even extend to the isolated islands of the southeast. Certain of these, such as *Cerion agassizi* found fossil in the cut at the Queen's Staircase in Nassau and *Hemitrochus varians* found fossil in a road cut on top of the high hill back of Governor's Harbour on Eleuthera Island certainly date their origin to the dynamic period of dune formation. Others, however, may have been dispersed mechanically since the Bahamas became fragmented.

It is of value, however, to note that *Hemitrochus varians*, the most abundant species numerically at any one place and one with the widest variety of habitats is the species most generally distributed in the islands. From a numerical point alone, it stands the greatest chance of being carried from one place to another and its arboreal habit adds materially to its distributional opportunities.

A recent paper by A. Gulick, (1932, p. 405–427) gives considerable

data on the number and types of animals and plants that are known to occur on a few oceanic islands. The islands under consideration are those that are universally accepted as "unmistakable oceanic islands . . . . whose terrestrial fauna acknowledgedly cannot have arrived by the land-bridge method."

All of the islands enumerated by Gulick exist at far greater distances from other islands and continental land areas than do the islands that compose the Bahama archipelago. As far as known, none occur in regions receiving the number of hurricanes that frequent the West Indies. If such islands have been successfully populated even in a very limited way by mechanical means, a postulate of the same sort for the origin of the Bahama fauna and flora does not appear impossible but highly probable.

The origin of the vertebrate fauna is much harder to account for—particularly by any hurricane method, but the possibility of rafting certainly falls within the realm of chance dispersal. According to Gulick, Marcus Island in the mid-Pacific area possesses two Polynesian species of reptiles, a gecko and a skink (p. 407) yet the nearest land, the Ladrone Islands, is 600 miles to the southwest. An endemic species of skink occurs on the Bermudas. These islands are distant some 575 miles east of continental North America and 840 miles northeast of the Bahamas. In both of the above cases, reptiles have managed to survive transport over a very great distance of open water. Other examples could be quoted from Gulick, but the above indicate the possibility of colonization by some means of mechanical transport.

In connection with Bermuda, certain species of snails, *Physa cubensis* Pfr. and *Polygyra plana* Dkr. are identical with those of the Bahamas and *Helicina convexa* Pfr. of Bermuda differs only slightly from a variety, *H. convexa rawsoni* Pfr. of the Bahamas. It would appear that the three species have reached the Bermudas directly from the Bahama Islands, only the *Helicina* has become somewhat differentiated. These are only two of the several that have reached the Bermudas from other areas.

The raccoon, which occurs only on the island of New Providence in the Bahamas, has been considered as a race or subspecies of the widespread North American raccoon. In a recent conversation I have had with my colleague, Dr. Glover Allen, he stated that this particular "race" of raccoons could possibly date from a recent introduction, probably during early colonial times. Catesby (1731, p. xxix) makes no mention of the raccoon as occurring in the Bahamas, though he gives a general account of its range and habits in North America. Such an

animal would certainly have been brought to his attention had it occurred on New Providence at the time of his visit in 1725. For the Bahamas, except the Jutia, which he calls the "Coney," he has listed only domesticated animals and a rat, this latter probably the introduced brown roof rat.

James Bond, in a general account on the distribution and origin of the West Indian avifauna (1934, p. 348) considers the Bahamas as oceanic islands. He does not, however, give any reasons for this statement but claims otherwise that "the resident Bahaman bird fauna has been chiefly derived from Cuba and Florida, the more distinct and older forms being predominantly Cuban, the Florida element being mostly confined to the northeastern islands."

The occurrence of the fresh-water turtle, *Pseudemys felis* Barbour, at Tea Bay, Cat Island, may possibly be an introduction by man. It does not appear necessary to consider this species as a remnant of a fauna dating from a previous land connection with Cuba or elsewhere, nor do we have to suppose that the entire fauna of these islands is of hurricane origin. Recently my friend, Dr. T. Barbour, has published a note on this species of turtle (1937, p. 164) and stated that he believed it would be utterly impossible for this animal to reach Cat Island by the caprice of any hurricane. With this I fully agree, but no consideration is given to the possible introduction by man. The ecological situation which *Pseudemys* occupies on Cat Island is fairly large; that is, the rocky-bottom pond area behind the lithified dunes near the western coast of the island, yet the turtle is limited to a very small part in this habitat at Tea Bay. It would seem to us that such a restriction of territory occupied would have some explanation, and that a comparatively late introduction of this species would be a possible answer. As far as we could learn, this turtle is not eaten by the natives, so its absence from potential areas is apparently not due to this cause. We were very politely informed that the Bahamians do not eat "insects"! That it differs somewhat from its nearest Cuban relative does not appear to be an insurmountable difficulty in explaining its origin. The speed of differentiation of animals under conditions of isolation is not known, but that such a condition can occur in a comparatively limited time is exemplified by the various breeds of domesticated cattle found on certain of the islands and island groups off the coast of Europe. Unit populations, possibly and probably derived from a very few or even single individuals would naturally show a surprising uniformity among themselves. Cases of this sort are exceedingly abundant among mollusks.

Again, we do not possess a complete series of *Pseudemys* for comparative study from all of the river systems of the Greater Antilles. This form may still remain undetected somewhere within the range of the genus.

Primitive man may have been responsible for some introductions. The use of these turtles for food may have prompted some Indians or even early Spanish sailors to provision their boats for a voyage from the Greater Antilles to the Bahamas. Again, some early colonial may have purposely brought them for use as food or for pets. At the present time Commissioner Malone of Simms, Long Island, possesses several Gopher Turtles (*Xerobates*) that he imported from Florida. If these turtles escape or are released they may well become a definite part of the reptilian fauna of Long Island. Conditions are ideal for these animals on most of the Bahamas. Such an introduction, unrecorded, would naturally lead to considerable speculation a few years hence if they were to be rediscovered in a wild state.

The distribution of *Geocapromys*, the Jutia, may have been extended by the Lucayan Indians to the more remote islands. They are easily tamed as pets and their usefulness as food, particularly during any sea voyage, may have prompted an occasional use of these animals.

During April, 1936 while exploring the islands of the Little Bahama Bank (Grand Bahama, Little, and Great Abaco Islands) by means of a seaplane, Mr. James Greenway and I noted a remarkable line of drift material along the northern portion of Great Abaco Island. This drift of trees and brush was well over two miles inland in many places from the western shore line of this island and upon ground investigation it was estimated conservatively to be 15 feet above the present or normal high tide level. In places this mass of debris was 5 to 8 feet deep and 20 feet wide. This was caused by the very severe hurricane of the previous year. A portion of this debris was probably derived from Grand Bahama Island and other small islands to the west of Great Abaco, which lie at no great distance from this island. The possibility of rafting animals at this time must have been exceedingly great to judge entirely by the enormous amount of drift that was seen. It is important to realize the abnormal height of water brought about by such a storm. This would have a two-fold effect in driving out animals over portions of the flooded land in one area and with the debris, depositing them well inland in another. Even if we grant optimum topographical conditions in this particular region, for the height of water and the abundance of drift material, chances, very much less than these, over any period of time would still offer many similar opportuni-

ties. Such conditions would not appear to be entirely inimical to vertebrates as a mode of involuntary transportation.

There is no question but that the present day fauna and flora of these islands is somewhat poorer than that existing in pre-Columbian times. A recent sending of cave material from Great Exuma Island contained the bones of an extinct variety of Jutia (Allen, 1937, p. 369) only recently described from a similar deposit on Crooked Island (Lawrence, 1934, p. 189). In addition, the bones of two new species of hawks and a large owl was contained in these remains from Exuma, (Wetmore, 1937, p. 427). Catesby (1731, p. xxxviii) records the presence of the West Indian seal on the Bimini Islands. These latter of course have long since disappeared from the Bahamas and the former from the earth.

The vegetation could never have been luxuriant except in limited areas to judge by Catesby's statements relative to the rather thin soils and exposed rocky regions that he found during his early visit to the islands (*ibid.* pp. xxxix–xl)..... "Tho the Trees on these rocky islands grow generally not so large as in Virginia and Carolina, where the Soyl is deep, yet it is amasing to see Trees of a very large size grow out of Rocks, where no Soyl is visible, and the Rock solid and compact, before the roots found a way to separate them, particularly Mahogony Trees, which are usually the largest Trees, these islands afford, and are commonly three, and many of them four foot through."

The above record of Catesby would indicate that the conditions during the early post-Columbian period were somewhat different than now, and that much of the island areas other than mangrove swamps (Grand Bahama and Andros) and some pine land have suffered materially from human occupation. Naturally, any pronounced change in the ecology of these islands would bring about a modification in both the fauna and flora. These changes would be detrimental to many species, particularly animals, and species introduced by man would hardly offset the losses brought about by the altered conditions.

Summary

Our contention, based principally on the land shells, is that the fauna of the Bahama archipelago possibly dates only from the Pleistocene and that it has reached the Bahamas by fortuitous means.

If at any time a land connection existed between the Bahamas and the islands to the south, such a connection disappeared, the islands

were submerged, and since their emergence, there has been no further land connection.

Certain genera, such as *Cerion* and *Hemitrochus* reached the islands at least during the active period of dune formation, presumably at a time when the islands were much larger than now.

The present land and fresh-water mollusk fauna is disharmonic and as such, would indicate an origin by means other than any land connection.

The mollusk fauna of the Bahamas is composed of species from Cuba, Hispaniola, southern Florida and a genus, *Sehasocheila*, is known to occur only in Central America and Mexico. Most endemic species and species groups of the Bahamas are closely related to species in Cuba and Hispaniola.

The proximity of islands to one another rather than the probable geological connections between such islands, exhibits faunistic relationships, and these relationships would indicate mechanical rather than a previous and normal migrational distribution.

Cat Island

A period of five weeks, during July and August of 1935, was spent on Cat Island, Bahamas, and included a two-day trip to Little San Salvador Island off the northwest end of Cat Island.

Studies were made mainly of the land and fresh-water mollusks, especially the colonial development and distribution of the genus *Cerion*. However, collections of other groups were made, particularly of reptiles, amphibians, fresh-water fish, insects, spiders and echinoderms.

The party consisted of Henry D. Russell, John H. Huntington and the author.

Cat Island forms an eastern arm of the Great Bahama Bank, though its connection with the Bank is only by a very narrow submerged strip about 27 miles long between the north end of the island west to the southern end of Eleuthera. Little San Salvador Island and a few small keys associated with it are situated about two-thirds the distance between Cat Island and Eleuthera on this connecting strip. Cat Island itself is 42 miles long and possesses an average width of 4 miles with an approximate land area of 160 square miles. Its long axis trends N. W. to S. E.

Our own collecting was limited to the northern fourth of Cat Island and to Little San Salvador. Emanuel Williams, a native of the former

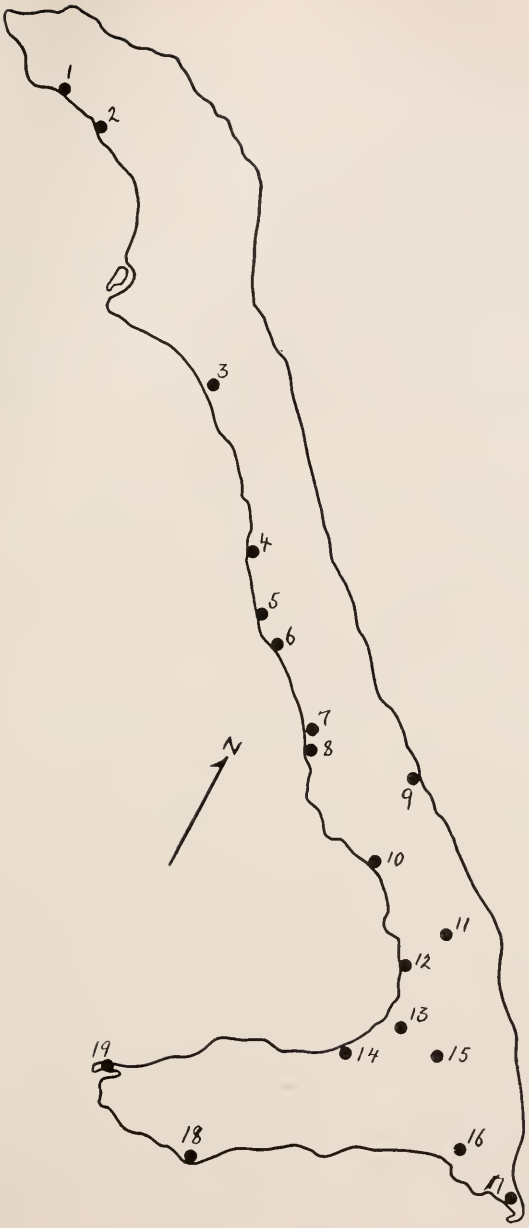


Fig. 1
Cat Island
(about 8 miles to one inch)

1. Orange Creek; 2. Arthurs Town; 3. Roker Settlement; 4. Cove Settlement; 5. Tea Bay; Drum Rainie, ½ mi. E. of Tea Bay; 6. Hollywood; 7. Knowles; 8. Smith Town; 9. Turtle Cove; 10. The Bight; 11. Tennent Hill; 12. Old Bight; 13. Gambier Lake; 14. Joe Sound Creek; 15. Bain Town; 16. Port Howe; 17. Columbus Point; 18. Devil Point; 19. Hawksnest Point.

island, made two trips of several days each for us to the southern part of Cat Island for *Cerion*.

Cat Island possesses the highest altitudes known in the Bahamas, the highest point being about 400 feet near the approximate center of the island and not far from the town known as The Bight. Many ridges run the length of the island and are generally about 150–200 feet high. However, they are not always parallel nor continuous for any distance, but are broken by gaps and occasional intersecting ridges. Their main direction is, however, with the long axis of the island.

In the vicinity of Arthurs Town, the region we personally explored, the island is about 4 miles wide, reaching a width of 5 miles about 3 miles south of the town. With the exception of Mr. Albury, the resident commissioner, the island population of about 4000 people is composed entirely of negroes. The natives live in small picturesque villages that are scattered along the western side or "inside" part of the island. Their small whitewashed stone houses are usually surrounded by clumps of palms and bananas.

The western side is the part of the island reached by the mail and supply boat from Nassau. Port Howe is on the extreme southern end of the island and the only place of any importance on the exposed outer coast. On all but the western side the water is of considerable depth just a very short distance off shore; 2194 fathoms are recorded 10 miles east of Columbus Point. The entire western side between Hawksnest Point (south end) and Man o' War Rocks (north end) shelves to the west rather gradually for some 10 miles to a depth of 40 to 50 fathoms and then suddenly drops into the deep water of Exuma Sound. The only continuous shallow area is the narrow strip mentioned above connecting the northern end of Cat Island with Eleuthera.

Arthurs Town is on the western side, 4 miles S. E. of the northern tip of the island. It has a population of about 300 people, and their dwellings are mainly within a few hundred feet of the shore. Immediately behind (east of) the town, the land rises to about 20–30 feet to form a flattened ridge. This ridge is about 1500 feet wide, and is covered with a low scrub, occasional areas being given over to farming.[1]

Beyond this first ridge there is a half mile of "swamp land," a sec-

[1] The farms, at least throughout the northern part of the island, are worked entirely by hand. Areas of sandy loam are very limited, though a long and very narrow strip occurs along the eastern side of the island. This is termed locally as the "white land." Nearly all other areas are rocky and the soil is to be found in the solution holes and between the large ledge limestone blocks.

Fig. 2

Northern Cat Island

(about 2 miles to one inch)

1. North End Point; 2. False Creek; 3. Port Royal; 4. Blue Hole Hill; 5. Grape Point; 6. Bat Hole; 7. Russell Creek; 8. Orange Creek; 9. The Lot; 10. Mt. Pleasant; 11. Fountain Hill; 12. Arthurs Town; 13. Zion Hill; 14. Dumfries; 15. Laurimore; 16. Winding Bay; 17. Coarsand; 18. Barrataria; Stormy Battle; 19. Zingo Hill; Anguilla; 20. Smoky Point Lake; 21. North East Point; 22. Wilson Bay; 23. Bennetts Harbour; 24. Rock Cay.

tion which presents one of the most remarkable areas on Cat Island. It is not in any way a swamp as the term is understood in the United States but rather an area of very slightly rolling country, covered with a nondescript growth, including cocoplums and palms, with many small, shallow, fresh-water ponds. The entire area, as we found it, is mainly exposed aeolian limestone with very little soil cover in the areas between the ponds. During very wet weather many of these ponds are connected and probably they are dry after any considerable period of drought. About three miles N.N.E. of Arthurs Town we were shown two "fountains," very deep pools in solid limestone rock which probably correspond geologically to the cenotes of Yucatan. Fresh-water fish are found in considerable numbers in these "fountains," and they undoubtedly supply the fish in the temporary ponds in their vicinity during the flood stage. We did not find any fish in the temporary ponds that were distant from the "fountains" or cenotes mentioned above.

East of this region of ponds, the land rises abruptly to about 100 feet (3 miles east of Orange Creek this ridge is nearly 200 feet high) to form a plateau, with an average width of about 1½ miles. This plateau is covered, similar to the low ridge back of the town, with a scrub forest and is also farmed in a few places. East of this plateau the land drops to nearly sea level, is swampy in spots, and possesses many small brackish lakes or ponds. From this, the land again rises to form a fairly broad and somewhat rounded, sandy loam ridge. Here is found the best farm land which is cultivated extensively for corn, tomatoes, a little sisal and coconuts.

The outer sandy beach is fairly steep, having in some places flat limestone ledges and in others the usual small, rocky points of dog-tooth limestone separating short or long stretches of sandy beaches. The flat ledges are closely allied to the "coquina" rock of the Florida east coast, though the component grains comprising this rock are much smaller than the Florida rock found near St. Augustine. A reef extends about 17 miles along the northern and northeastern portion of the island.

Some 4½ miles N.N.E. of Arthurs Town there is a sizable salt-water lake known as the "Blue Hole." This is about two miles from the ocean from either side and except for a low area on its northern end is, as far as surface areas are concerned, completely isolated from the ocean. The low mangrove area on the northern end connects with another lake about one half mile away. The "Blue Hole" is very deep and possesses all of the features common to a small arm of the sea, with

tides, a marine fauna and, in addition, is margined with very heavy growth of mangrove. It unquestionably possesses a large subterranean connection with the ocean. A great many superstitions are associated with this place and no native will ever venture in it or even on its surface. Undefinable "creatures" are recorded locally and even mermaids have been reported!! It is possible that sharks or barracudas, both of which are common on all sides of the island, may occasionally frequent this place and that the sight of these has given rise to the stories.

One and one-half miles northwest of Arthurs Town is located the little village of Orange Creek. This village is on a "creek" of the same name. In reality this "creek" is a shallow tidal lake about a half mile wide at its widest point and one and one-half miles long. It is connected with the ocean by a shallow opening about 100 feet wide. At low tide this lake is nearly dry and possesses extensive sand and mud flats.

We saw no true streams on the island as the drainage is almost entirely subterranean; but midway in the "swamp land" we crossed a creek bed which was dry at the time we were on the island. This flows during a period of heavy rain.

Names for areas on the island exist in great abundance. Boundaries are defined mainly by the many trails that cross the island in all directions. We have indicated on the map all such names that are in any way associated with the material collected. The origin of most of these names lies buried in the Island's past history, though the origin of many could probably be determined by a perusal of the original land grants that were made in the eighteenth century. These grants were made mainly to loyalists from the American Colonies during and after the Revolution, these being the first whites in any number to settle the Island.

The unfortunate practise of burning the vegetation to clear the land is causing the soil to disappear fast. If this continues, in a few more generations, there will be little or no agriculture possible.

A small area is partially cleared, usually the largest trees are cut down and then allowed to dry. A day is selected for burning after a period of several hot sunny days. Late in the morning the brush is fired and in a short time nothing is left but a few charred stumps. Much of the top soil burns as it is composed almost entirely of humus. Most of the areas we noticed being cleared in this manner possessed a 10 to 15 year stand of scrub growth. Such cleared ground appears to be fairly productive the first year only, though it is usually farmed for

two to five years after each burning. The little soil remaining after such fires is soon impoverished both by the crops planted and through leaching. A new farm area is then selected and the firing process repeated. The abandoned farm ground gradually comes back into scrub and eventually is burned over again.

All stages of this clearing process were encountered in different parts of the Island, and other than the "white land," which is composed mainly of sand, the only real soil cover was found in the cemetery at Arthurs Town. Several feet of soil covers the rock at this place and its existence is due to the fact that the grass and brush is cleared off by cutting.

In the past history of the island, one reads of the noble estates that existed and the comparatively large fortunes made by their owners. These estates existed prior to 1840 during the days of slavery and after abolition the enormous estates practically disappeared and now only exist as a background in the Island's history. One is certainly suspicious that these estates failed more through the loss of the soil than the loss of the labor to work them. It is a paradox certainly when a country is predominately agricultural and yet cannot use a plow! Today, the entire mechanics of crop culture is limited to a grub hoe. Conditions are not so serious all over the Bahamas, as many parts of Eleuthera and New Providence are still very productive, but the same general destructive measures appear to be employed everywhere, and it is only a matter of time when these areas will be as non-productive as the sections seen on Cat Island.

One of the most astonishing discoveries was the enormous number of "Red Peggies," the Black Widow Spider, *Latrodectus mactans* (Fabr.). These were found under nearly every loose rock and under many dead palm fronds. During the time of our stay a girl was bitten, though the bite did not prove to be fatal. Several cases of bites that had occurred previously were brought to our attention, only one of which had been fatal. The victim was said to have lived only 10 hours after he was bitten.

Large ground spiders (Therophosidae) are to be found, though not particularly abundant.

Surprisingly enough, mosquitoes were not at all troublesome, notwithstanding the fact that we were located on the edge of a rather extensive brackish pond and not a great distance from the numerous fresh-water ponds of the "swamp land." A strong sea breeze may have helped to keep them away, but on our numerous daily trips we never noticed them at all even when the sea breeze could not be felt.

Marine collecting was necessarily limited as our main interest was connected with the land and fresh-water fauna. A list of the lamellibranchs has been published (Clench and McLean, 1936). The gasteropods obtained will be included in a list of all the known species found in the Bahamas. The appended list of echinoderms was furnished by Dr. H. L. Clark, based upon the material collected. All specimens of echinoderms were collected in a very small cove at the south end of Arthurs Town and all but *Oreaster reticulatus* were found under loose rock, the latter species occurring on exposed sandy bottom in 2–3 feet of water.

Little San Salvador

The island of Little San Salvador, as mentioned above, lies about two thirds of the distance between Cat Island and Eleuthera and is situated on the narrow submerged ridge connecting these two islands. The water covering this submerged ridge between Cat Island and Little San Salvador is exceedingly shallow (1 to 3 fathoms), with a few small rocks and keys near the Little San Salvador end. Numerous coral patches cover this ridge and many of them are awash at low water. The continuation of this ridge between Little San Salvador and southern Eleuthera is very much deeper (8 to 10 fathoms).

Little San Salvador, called locally on Cat Island "Little Cat Island" or just "Little Island" is 5½ miles long and approximately ¾ miles wide. A large "creek" occupies much of the central area and is connected with the ocean by a narrow opening on the south side of the Island. This "creek" which is similar to the one at Orange Creek on Cat Island possesses extensive sand flats at low water. It deepens considerably in the central and western end. This latter portion can easily be reached by walking a few hundred feet overland from Salt Pond Bay on the southwestern side of the Island. It is very rich in marine life and we found some of the finest collecting in and about the mouth of this area.

The Island is uninhabited, though farmed in very limited areas by people from Cat Island. The statement by Agassiz (1894, p. 34) that it is "low, not more than twenty feet high" is erroneous. He did not, however, visit the island, but judged its height during his cruise along its shores. Ridges on the north side of the "creek" are 100 feet high and many other sections of the island exceed 50 feet in altitude. Structurally, it is similar to Cat Island with large exposures of aeolian rock and sections of "white land." It possesses in places a much better

soil cover, simply because it has been much less cultivated, and fewer fires used to clear the land. Excellent anchorage is to be found, even for very large boats just off Salt Pond Bay on the south side. The deep water of Exuma Sound reaches within 1000 feet of this cove, and for small boats ample protection is to be had from all quarters other than the southwest, a region from which the wind seldom blows in this particular area. Near the small automatic light on the south side is found an excellent example of a lithified dune running north and south, completely and vertically truncated by wave erosion. This forms a sea bluff 15 to 20 feet high and its arched, laminated structure can be studied in detail.

Both *Cerions* and *Cepolis* were rare, though it is more than possible that colonies of both are to be found in numbers in sections we did not explore. Our time on the island was limited to a day and a half, and only a very small area was covered in this time. No *Cerions* or *Cepolis* were found on Goat Key, a small island of only a few acres in extent and about 50 feet high, lying about one mile off the northeastern end of Little San Salvador. Bird Rock and Sandy Key were not visited. Our collector, Williams, who had spent considerable time on both of these little islands could not recall having seen any land shells.

Our personal thanks are due to several friends of the Museum who, through financial aid, made this trip possible, and in addition to C. M. B. Cadwalader, Director of the Academy of Natural Sciences, Philadelphia, and F. M. Gaige, Director of the Museum of Zoology, University of Michigan, who supported the expedition in part for a share of the material collected. Duplicate collections of the mollusks obtained are deposited in these institutions.

We are also deeply obligated to members of the Development Board of Nassau, especially to Miss Sylvia Johnson and Mrs. H. Kelly for their assistance in supplying information and their willingness to cooperate in every possible way to make our expedition a success.

To the Bahama Government we wish to express our thanks for the use of a splendid dwelling house at Arthurs Town and to Mr. H. Christie for his very friendly interest and permission to photograph his colony of flamingos on his estate near Nassau. To Mr. Albury, Commissioner of Cat Island at the time of our visit, we are very grateful for his assistance in many ways and for his continued interest in our expedition throughout our stay on the Island. To the people of Arthurs Town and Orange Creek we wish to acknowledge our gratitude for a host of favors and for their friendly interest. Particularly among these people we owe our indebtedness to David and Reginald Poitier

and to Campbell, Clark, Bowleg and MacDonald for their many favors and courtesies.

Last, but not least, we are grateful to our "boys," Al Newbold, Ben Hepburn and Manny Williams for their willingness and hearty cooperation.

Ecological Areas

Aquatic habitats. In the introductory note there was mentioned the existence of several types of ponds on Cat Island. These ponds can be readily divided into four very distinct types, none of which are joined with the sea by any surface connection. In this classification, the "creeks" are not considered, inasmuch as they are really arms of the sea, reaching inland some distance by means of shallow and rather narrow entrances. These four types of ponds can be considered as follows:

1. Salt or brackish water
    a. Shallow salt marsh ponds.
    b. Deep "Blue Hole" ponds
2. Fresh water
    a. Temporary shallow ponds
    b. Permanent deep ponds.

Salt marsh ponds. A typical pond of this sort parallel to the coast, ran well beyond the limits of Arthurs Town in both directions, a distance of about two miles, and seldom reached a width of more than three-hundred feet. It was crossed at regular distances every few hundred feet in the town proper by fills built to form narrow roads. In many places, it was less than one-hundred feet from the sea, and separated from the sea by a rocky ridge six to ten feet high throughout its length. A small, two foot drain had been cut through the ridge near the main part of the village to keep the pond level fairly low.

Severe storms, particularly hurricanes, carry quantities of salt water over the rocky rampart and consequently keep the water brackish. There may, of course, be subterranean connections, but these, if they exist, could not be detected. Mangroves are found about the edges in many places and probably were all about the pond originally.

Ponds of this sort are particularly abundant along the east or outside margin of the island, usually only a short distance from the sea. They vary materially in size from those of an acre or so in area to one approximately a mile in diameter. It would appear that these ponds, particularly the larger ones, form a stage in the geologic history of the

"creeks." A narrow opening cut through the beach rampart, allowing the sea access to the low area behind would shortly develop such a place. Their surface is only slightly above or equal to that of the ocean at high tide.

Deep "Blue Hole" ponds (salt). We visited only one pond of this sort, though we were told that others existed on the island. As mentioned elsewhere, there is no surface connection between this pond and the ocean. This particular pond was about 4½ miles N.N.E. of Arthurs Town and roughly about one-fourth mile wide and one and one-half miles long. High land was found on all sides but the north where there was a mangrove swamp about one-half mile long between this pond and another one. It possessed a tide of about two feet and had a definite saltwater fauna. It is very deep, how deep we cannot say as we possessed no means of getting out to make soundings. The natives are extraordinarily afraid of the place and will hardly venture even within the limits of the mangrove fringe which skirts the entire margin of the pond. It unquestionably possesses subterranean connections with the ocean as the mangrove area on the north was only covered with a few inches of water during the full high-tide.

Temporary shallow ponds (freshwater). East of Arthurs Town, about one-half mile from the sea, there was a low, somewhat slightly rolling area that extended for one-half mile in an easterly direction and better than two miles in a general north and south direction. Within this area there was a vast number of small ponds, individual ponds seldom exceeding 200 feet in diameter. These small shallow freshwater ponds were separated by rounded ridges of limestone with patches of thin soil cover. Palmetto, cocoplums and sedges made up much of the vegetation growing on the thin soil of this area. Most of these ponds are dry during the late fall and winter but well filled during the rainy period of the year. We collected a few freshwater mollusks in these ponds that were not obtained elsewhere.

Permanent deep ponds (fresh-water). Two very deep ponds were found east of Orange Creek, the first about one-half mile and the second about one and one-half miles. These were called "fountains" locally and were said to contain water always. The most important element in these two places was the presence of fresh-water fish which occurred in considerable numbers. A few of the temporary ponds in this vicinity also possessed fresh-water fish, but apparently these were derived from the "fountains" during the high water stage. Both of these "fountains" occurred in the area of temporary ponds mentioned above.

A recent publication by Pease, Creaser and Hall (1936) describes in detail the geological formation and the fauna of the cenotes of Yucatan. It would seem, to judge by the description of the above authors, that the two "fountains" that we encountered on Cat Island were small cenotes quite similar to those occurring in Yucatan. The one nearest to Orange Creek had a high undercut west wall fifteen to twenty feet high. The approach to the water had to be made in its eastern side which was quite steep but not at all precipitous. The second "fountain," or cenote, was filled nearly to the brim with clear and rather cold water. The bottom could not be seen.

The temporary ponds that we encountered were similar to the "aguadas" mentioned in the above report (p. 12). They were, however, much shallower. Hall quotes Cole as suggesting that the "aguadas" are partially filled in cenotes and advances his own theory that certain of them "represent a persistence of sea bottom depressions that were never caverns or wells." Of the two theories, the latter certainly is more plausible for the ponds that we encountered, inasmuch as their bottoms under a few inches of mud were composed of solid rock and not the débris from erosion of their margins as was suggested by Cole.

On somewhat higher ground we found several small, dry "sinks," eight to fifteen feet deep and about the same in diameter. Rich soil occurred at the bottoms and were generally used by the natives to grow bananas. The differences between these sinks and the cenotes is really a matter of degree, the latter being smaller and drained. We were told of much larger sinks than those that we had seen, and it is quite possible that the two are geologically the same thing.

Land habitats. With the exception of *Cerion, Hemitrochus* and *Plagioptycha,* the few species of land mollusks found on Cat Island are mainly cryptic. During rains they move about a little, but generally they remain under stones or débris.

Inner coastal strip. The western fringe of this island is quite irregular ecologically, but in the main, is composed of low lying "diente de perro" and short sandy beaches. Below Bennetts Harbour the land rises somewhat to form bluffs several feet high. We have not seen this section but it is probably like the north central inner coastal area of Eleuthera where there are bluffs 20 to 60 feet high, undercut at the water line. Behind this coast the land for a few hundred feet to one to two miles is slightly elevated, rolling and in places possesses the brackish swamps and fresh-water pond areas described elsewhere. Sandy-loam areas are not abundant but where they occur they are intensively cultivated.

Ridge area. The central part of the island is composed of irregular rocky ridges covered generally with a low scrub forest. Several patches are burned and farmed. This is the richest in mollusks and the rarer forms such as *Urocoptis, Microceramus, Helicina,* the Pupillidae, etc., are met with in greater abundance than elsewhere. Loose rocks abound and ample cover is provided for the secretive forms. *Cerion* is absent as well as *Polygyra.*

Outer coastal ridge. This is a sandy-loam or "white land" area which runs along the eastern coast behind the beach proper. It is generally cleared and farmed. Uncultivated areas possess thickets of scrubgrowth, grass and spider lilies. *Cepolis* and *Cerion* usually occur here in the greatest profusion. The *eximium* group of races is absent entirely, only the larger forms, *russelli, felis* and *huntingtoni* are to be met with. West of this ridge is usually low lying with many brackish ponds and swamps. *C. eximium* is, however, found in this area.

Marine habitats. Marine conditions in the Bahamas are more or less uniform throughout the entire archipelago, particularly on the islands that form the easterly margin of the Great Bahama Bank, Eleuthera, Cat and Long Islands.

The outer, or northeasterly, sides of these islands consist of long and short stretches of beaches interrupted by rocky headlands and bluffs. Exposed as they are to the easterly trades, there is very little protection afforded and the fauna is limited not only in species but in numbers of individuals. This coast is nearly devoid of bays, inlets or places where protection can be had from the full force of storms. When such exists, there is usually an abundance of marine life.[1]

The southwest coasts are far more irregular in outline, with numerous bays, harbors and "creeks" and, of course protected as they are from the tradewinds, are much richer in marine forms. This is also the "bank" side of the islands and the sea is comparatively shallow for a considerable distance offshore.

Due to the lack of suitable habitats particularly in the form of mud flats minute species are comparatively rare. Mud with a high content of organic matter is exceedingly scarce and exists only as small patches at the heads of the "creeks" which usually support areas of mangrove. Even here the conditions have become altered as these areas are generally brackish and consequently exclude forms peculiar to a purely marine existence. The western side of Andros Island is known

[1] Savannah Sound on the northeast side of Eleuthera is a narrow strait some 6 miles long and about ¼ of a mile wide. Ample protection is to be found and conditions are ideal for marine forms. A more detailed account of this area has appeared elsewhere (Clench and McLean, 1937, p. 33).

as "The Mud." This area is composed of a calcareous mud derived from the western shore of this island and, according to Miner and Dahlgren ([in] R. M. Field, 1931, pp. 769–774) was found to be exceedingly poor in marine life. This is probably due to both the chemical and physical nature of this material, that is, the lack of suitable organic detritus upon which many of the small mollusks feed (the above authors report that "vegetable debris was sometimes locally abundant") and also because of the turbidity of the water which occurs after storms or even during moderate winds which cause sufficient wave action to stir up the bottom.

There are no surface streams of fresh water on Cat Island or, for that matter, anywhere in the Bahamas[1] as the drainage is all subterranean, and as a consequence there is little or no opportunity for land sediment to reach the sea in any appreciable quantity. What little does reach the sea, is generally carried away by the shore currents, the only exception being, as mentioned above, at the heads of certain creeks.

In general, the littoral marine mollusks of the Bahamas are similar to those of the Greater Antilles. Far more collecting is necessary before any accurate comparative studies can be made, but the differences found between the Bahamas and the islands immediately south will probably not be very great. The difficulty is in a proper understanding of what constitutes the limiting factor in the non-occurrence or lack of abundance of certain species in the islands, species which occur both in Florida and in the West Indies under conditions more or less approximating those of the Bahamas. Mechanics of distribution are certainly not enough to explain the presence or absence of a species in this region, particularly when comparisons are made with adjacent and similar territory. This is true when a species is known to occur both in the Bahamas and elsewhere, but only known from a single or few specimens in the former territory and found abundantly in other portions of its range.

The student of geographical distribution is faced with gaps in the record of marine forms that are not due altogether to the unexplored portions of a species range. Factors in the ecology of a species must be discovered before any clear picture of its distributional pattern can be had.

Anomalies in the distribution of many Bahama species seem to be far more erratic than elsewhere, as for example species occurring on the

[1] Fresh Creek on Andros is not a true creek, but a tidal channel that is fresh or only slightly brackish at its source.

west coast of Florida. Species found along this latter area are surprisingly uniform in their distribution between Cedar Keys on the north and Pavillion Key on the south, a distance of some 275 miles. Many species, of course, are not found extending throughout this range, but within their range limits they occur more or less regularly under similar circumstances. On the other hand, all sorts of discrepancies are to be noted in the distribution of many Bahama species. The beaches at Arthurs Town possessed a remarkably different assemblage of lamellibranchs from the beaches in and about Governor's Harbour, Eleuthera. Both places are on the "inside" coasts of the islands and both have somewhat similar offshore physical conditions. Certain of the common species are, of course, found nearly everywhere but many others show surprising gaps between localities. The problem does not appear to be an easy one.

Geological notes

For general remarks on the geology of the Bahamas, reference should be made to Schuchert (1935, pp. 528–540).

Cat Island is distinctly hilly, a character held in common with other islands along the outer and eastern edge of the Great Bahama Bank. These hills are lithified sand dunes with portions of the outer ridge still composed of unconsolidated sand and light sandy loam which is known locally as the "white land." Similar but smaller areas of "white land" are found as well on the leeward sides of these islands.

Soil cover on the northern end of Cat Island is exceedingly light and in areas other than the "white land"is reduced mainly to the solution holes and depressions among the rocks.

Caves are to be found on most of the larger islands though they are not particularly numerous and nowhere are they extensive. Bat guano, which is found in many of these caves, has been and still is used for fertilizer, more extensively now than in former times as the tomato industry has received a considerable impetus during the past few years. There is no question but that much valuable cave data has been lost from all of these islands, due to their exploitation for guano, as the little investigation so far attempted in these caves has shown a comparatively high index of finds, mainly in the form of skeletal remains of small mammals, birds and even the bones of the extinct Lucayan Indians.

We saw no evidence in the form of elevated strand lines on the northern part of Cat Island. We did, however, find portions and whole

shells of *Strombus gigas* that were embedded in the coastal rock 6 to 10 feet above the present sea level on the south side of Little San Salvador. At several places along this coast there exists a terrace some 10 feet high with a vertical cliff rising as high as 20 feet behind it. Many places at the base of the cliff were undercut and probably this represents an old strand line. (The truncated dune mentioned elsewhere, p. 504, occurred along this part of the coast.) During April, 1936, Mr. J. C. Greenway and I noted a small but similar "undercut" on Mores Island on the Little Bahama Bank. We estimated this undercut at the base of a rocky hill (now inland about 250 feet) to be about 15 feet above the present sea level. In addition, we noted a remarkable feature on Grand Bahama Island. We had the advantage of seeing this entire island with a seaplane several times from the air. Other than a narrow fringe of low scrub growth of deciduous trees and bushes along the south side, the area of the island above sea level supports a stand of Bahama pine. This pine appears to be entirely limited to the rocky land where there is but very little soil. At many places we saw narrow, grassy swales cutting through the island from north to south and these appeared from the air to represent old "creek" beds that existed during a time of higher oceanic level and are now completely filled in. From a ground study, these old creeks would be unsuspected though they are definitely outlined from the air. Hawksbill Creek is now the only one of these former tidal creeks that has remained open. This creek flows alternately with the tide owing to a differential in tide level on the two opposite sides of the island. At the eastern extremity of Grand Bahama there is a series of long and comparatively narrow, low, rocky islands with narrow, shallow straits between them. These islands also support a stand of the Bahama pine. A change of as much as 15 feet in the present sea level would probably produce a similar condition as that noted above on Grand Bahama proper. However, it is quite probable that these small islands existed at the same time when Grand Bahama was cut by several creeks and have remained open owing to a difference in the speed of tidal flow. The eustatic change was probably slow enough for these straits to cut down their beds as the oceanic water was lowered. It is to be borne in mind that north of Grand Bahama the banks are margined only by the open sea while on the eastern end tidal drainage is blocked by both Little and Great Abaco and, as a consequence, the set of the current both on the ebb and flow of the tide is much stronger around this eastern end of Grand Bahama.

I have not seen Andros Island, but judging entirely by its known

low elevation, it is possible that the present channels which now divide this island, may have had their origin at the time of higher oceanic level and have since been able to maintain their courses by cutting down their beds. This same condition may have developed the present series of Exuma Islands and the long string of islands extending northwest of Great Abaco. These may represent the fragments of once larger islands and they are only the remains of former dunes that were subsequently cut through at their low points during this higher oceanic level (c.f. Daly, 1934, pp. 157–164, for evidences of a 5–6 meter change of sea level). This same process may also have produced the Berry and Ragged Island groups, both of which margin the banks.

Field (1931, p. 780) reports, on the work of Dixon, several strand lines at various elevations, all under 8 feet, along the western edge of Andros, the Berry Islands and the Bimini Islands, and upon this evidence, concludes that there has existed a "slight but distinct warping." Similar elevated strand lines that we have seen on the easterly islands are higher and may represent a eustatic change of ocean level rather than any vertical elevation of Little San Salvador or Mores Island.

Evidence of a one time lower sea level exists at Arthurs Town in the form of the remnants of a lithified dune that still margins the coast. It remains today as a series of miniature headlands, islets, or submerged rocks. A small section of this ridge formed a cove at the south end of the town. Elsewhere in the Bahamas there are the remains of dunes that have been similarly cut away by action of the sea, notably at West End, Grand Bahama Island and along the North coast of Little Abaco. At this latter locality, a series of rocks occurred a few hundred feet off Foxtown, which were undoubtedly the remains of a former ridge, as they were in a line paralleling the coast. Many of these rocks were reduced to only a few feet across and were mushroom in shape owing to the present undercut. Their tops were flat and appeared to be approximately eight feet high.

The speed at which this coastal limestone may form is indicated by the presence of extraneous objects, such as a piece of iron chain, parts of bottles and a small, 5–6 pound boulder of igneous rock, all of which we found imbedded in the limestone at Arthurs Town. These objects we had to cut out with cold chisels. We were informed by the natives that many boulders such as the one we found embedded, were common years ago on Cat Island but have long since been removed for building purposes. Their origin, of course, dates from the heyday of agriculture,

probably during the development of the pineapple industry when these boulders came as ballast in boats from the United States.

This would then indicate that certain of this limestone is very recent and has become consolidated in the space of a very few years. Small changes in the configuration of the coast line, brought about by shifting sand bars or storms, have now exposed this newly formed rock to erosion and the included objects are brought to light.

Systematic Account

Prior to our visit to Cat Island, there had been but few land shells collected. The records listed below are the results of only casual collecting by people limited in their time on the island.

During the winter of 1865–1866, Dr. Henry Bryant stopped for a short time at The Bight, Cat Island, while on his way to Great Inagua Island. A few species of shells were collected, one of which, *Helix salvatoris*, was described by Pfeiffer in 1867. The Cerions collected were identified as other species, now known to be limited to other islands. Confusion regarding the locality of *C. cumingiana* Pfr. lead Bland and others to consider the material of Bryant as this species. Later Pilsbry restricted this species to Cuba, and described the Cat Island form as *C. eximium fraternum*.

Later, Dr. J. J. Brown collected, probably in this same area on Cat Island, and published a short paper in the Conchologists' Exchange, 1886, **1**, pp. 12–13, on the material collected. Pilsbry described *Helix troscheli brownii* on specimens collected by Brown.

A few published records and some museum specimens possess localities as "San Salvador," a name employed as an alternate for Cat Island. This has lead to some confusion, as Watling Island in the Bahamas is also known as San Salvador. Cat Island is not to be confused with Cat Cay in the Berry Islands (north of Andros) and Cat Cay in the Bimini group.

Species in the following list, marked with an asterisk (*) are considered elsewhere in this report, the remaining species are misnamed or wrongly assigned to Cat Island. All geographic records without authorities were collected by the present expedition.

**Hemitrochus troscheli brownii* Pilsbry.

**Cerion eximium* Maynard.

**Cerion felis* Pilsbry and Vanatta.

**Cerion fordii* Pilsbry and Vanatta.

**Cerion fraternum* Pilsbry.

Cerion marmoratum (Pfeiffer) reported by Pilsbry and Vanatta (1896, Proc. Acad. Nat. Sci. Phila. p. 326) from Cat Island. This species is now known to occur only on Fortune Island in the Crooked Island group.

Cerion martensi (Weinland) reported by J. J. Brown (1886, Conch. Exchange **1**, p. 13) from Cat Island. It is known to occur only on Crooked Island in the Crooked Island group.

Cerion mumium (Bruguiere) reported by J. J. Brown (*ibid.* p. 13). It occurs only on the North Coast of Cuba between Matanzas and Havana.

**Cerion platei* Clench.

**Physa acuta* Dall (= *P. cubensis* Pfr., q. v.)

**Plagioptycha duclosiana salvatoris* Pfeiffer.

Original citations are given for all of the species in this report, additional citations are those in which references were made to Cat Island. The localities at which we collected or from which we received material are indicated on the two maps.

Land and freshwater mollusks

HELICINIDAE

Alcadia (Alcadia) fallax A. Wagner

Alcadia fallax Wagner 1907, Conchy.-Cab. **1**, pt. 18, sec. 2, p. 56, pl. 8, fig. 13–15 (New Providence, Bahamas); Clench 1937, Proc. New England Zoöl. Club **16**, p. 73.

A local and rare species, known only from the type locality and from the few localities listed below for Cat Island.

Records. Arthurs Town; ½ mi. N. E. of Orange Creek; Blue Hole Hill; Port Howe.

Helicina convexa rawsoni Pfeiffer

Helicina rawsoni Pfr. 1867, Malak. Blätt. **14**, p. 165 (Inagua Id., Bahamas); Clench 1937, Proc. New England Zoöl. Club **16**, p. 75.

This form appears to be only a subspecies of *H. convexa* Pfr. of Bermuda. The differences are slight but quite constant. The parietal callous is more granulose in the Bahama form and the lip is somewhat consistently thicker. However, other than these two characters, the two forms are very similar.

Records. Between Orange Creek and Port Royal.

POMATIASIDAE

Opisthosiphon bahamense ('Shuttleworth' Pfeiffer)

Ctenopoma bahamense 'Shutt.' Pfr. 1865, Mono. Pneumonopomorum Viven. **3** p. 115 (New Providence, Bahamas).

Opisthosiphon maynardi Vanatta 1920, Proc. Acad. Nat. Sci. Phila. **72**, p. 204, pl. 6, fig. 9–11, 13 (Nassau, New Providence).

This species was never described by Shuttleworth but was only named by him from material contained in the Cuming collection which had been received through Bland, possibly from W. Cooper or T. Smitten.

It appears to be well distributed throughout a large portion of the Bahamas, and it may occur in considerable abundance at a favorable station. Specimens are to be seen moving about a little after rains, but it is generally to be found under loose stones and rocks.

This species over its entire range in the Bahamas is somewhat variable, the variation not appearing to be particularly geographic. In a very large series from most of the islands, the same variations keep appearing. It would seem as though certain slightly different characters are segregated in small areas, even on the same island. Specimens from the island of New Providence are more consistently darker in coloration than specimens from most other islands, and examples from Long Island have the axial, blade-like ridges slightly wavy, but there are specimens from many other localities that approximate these characters. The sculptural pattern, however, shows the least amount of variation.

Records. Arthurs Town; ½ and 1½ mi. N. E. of Arthurs Town; Orange Creek; Blue Hole Hill.

Opisthosiphon bahamense insulae-felis new subspecies

Plate 2, fig. 1 and 7

Description. Similar in general characters to the typical form, differing quite noticeably in the sculpture. *O. bahamense* Pfr. possesses fine, blade-like ridges, numbering about 8–10 to the mm. This new subspecies has fewer, much stronger and higher ridges, numbering 3–4 to the mm. In addition, each ridge has a single bead or boss at the suture; in the typical form two and sometimes three ridges are generally fused. This is the character that produces the crenulated suture. Under a 14 power lens, a few, microscopic axial threads are just visible between the ridges.

Length 12.5; width 5.7; aperture 3 x 2.8 mm. (holotype).

Holotype. Mus. Comp. Zoöl. no. 107905, Port Howe, southern end of Cat Island, Bahama Islands. E. Williams collector, July, 1936. Paratypes from the same locality. All specimens dead when collected.

Remarks. O. bahamense barbouri Cl. from Watling Island is more or less intermediate in the character of its sculpture between this new subspecies and the typical form, but it differs in many other respects, particularly in the rounded and thickened lip, its smaller size and almost closed umbilicus. From *O. androsense* Pils. it differs in being larger and having only a trace of the spiral threads or cords.

Chondropoma canescens (Pfeiffer)

Plate 2, fig. 5

Cyclostoma canescens Pfr. 1851, Proc. Zoöl. Soc. London p. 245 (Locality not given).

A species widely distributed in the Bahamas and eastern Cuba, though not particularly abundant at any one place in the former area.

In habit, it appears to be quite solitary, preferring areas of scrub growth and loose surface stones. This species, similar to other closely related forms, is semi-arboreal, though active only during wet weather. It will ascend trees for a short distance and upon the weather drying, secrete a short mucous thread from which it suspends itself. Any slight disturbance, even a light breeze, will rupture this thread and the snail drops to the ground, remaining dormant until the next period of wet weather activates it again.

A comparison has been made between a large series of specimens from several localities in both the Bahamas and eastern Cuba. No differences could be detected to separate these forms, even subspecifically.

Records. Arthurs Town; 1 mi. S. E.; 3 mi. N. W.; and 4 mi. E. of Arthurs Town; Orange Creek; ½ mi. and 2½ mi. N. E. of Orange Creek; Winding Bay; Bain Town; 3 mi. N. W. of Port Howe.

ELLOBIIDAE

Melampus coffeus (Linne)

Bulla coffea Linne 1758, Sys. Nat. ed. 10, p. 729.

An abundant species in the mangrove swamps throughout the West Indies.

Records. Arthurs Town; Orange Creek; Russell Creek.

Melampus coffeus flavus (Gmelin)

? *Voluta flava* Gmelin 1792, Syst. Nat. p. 3436.
Melampus flavus, Binney 1863, Boston Journ. Nat. Hist. **7**, p. 166, fig. p. 167.

It is exceedingly difficult to separate these forms. It is quite possible that *flavus* is only an ecological variety of the more abundant *coffeus*.

Records. Arthurs Town; North East Point, 4 mi. E. of Arthurs Town.

PHYSIDAE

Physa cubensis Pfeiffer

Physa cubensis Pfr. 1839, Archiv. für Naturgeschichte **1**, p. 354 (Cuba); Clench 1936, Mem. Soc. Cubana Hist. Nat. **10**, p. 339, pl. 25, fig. 2.
Physa acuta Drap., Dall 1905, Smithsonian Misc. Colln. **47**, pt. 4, no. 1566, p. 448 (Mangrove Cay, Andros and Watling Island); 1905, The Bahama Islands. The Geographical Soc. Baltimore, p. 41 (Arthurs Town, Cat Island).

In a former paper (Clench, 1936, p. 339) I placed *P. acuta* Dall in the synonymy of *P. cubensis*, as there appears to be no difference at all between specimens from the Bahamas and those from other portions of the West Indies. It certainly is not the common European *P. acuta* Drap.

We found the species fairly abundant in the freshwater ponds east of Arthurs Town. Its present distribution in the Bahamas would indicate that it will possibly occur wherever there is any fresh water.

Records. Arthurs Town (Dall); ½ mi. E. of Arthurs Town; ½ mi. N. E. of Orange Creek.

PLANORBIDAE

So far as known, all of the large species but one of the Planorbidae are absent from the Bahamas. Dall records *P. redfieldi* C. B. Ad. from Andros Island, but this appears to be the only record. The specific identity of this record, however, is questionable.

The following forms were all obtained in the small ponds behind Arthurs Town and Orange Creek. Their occurrence in certain small dried up ponds (on Cat Island and Grand Bahama Island) would indicate either the comparative ease in transport between such places or else their ability to withstand fairly long periods of desiccation, a condition which may be passed over during adult life buried in the dried pond soil or in the egg stage in the debris of the pond bottoms.

Drepanotrema cimex (Moricand)

Planorbis cimex Moric. 1839, Mem. Soc. Phys. Geneve **8**, p. 143, pl. 3, fig. 8–9 (Bahia, Brazil).

Records. Arthurs Town; ½ mi. due E. of Arthurs Town; ½ mi. N. E. of Orange Creek.

Drepanotrema lucidum (Pfeiffer)

Planorbis lucidus Pfr. 1839, Arch. f. Naturg. **5**, pt. 1, p. 354 (Cuba).

Records. Arthurs Town; ½ mi. due E. of Arthurs Town; ½ mi. N. E. of Orange Creek.

Planorbula albicans (Pfeiffer)

Planorbis albicans Pfr. 1839, Archiv. f. Naturg. **5**, pt 1, p. 354 (Cuba).

Records. Arthurs Town; ½ mi. due E. of Arthurs Town; ½ mi. N. E. of Orange Creek.

Tropicorbis havanensis (Pfeiffer)

Planorbis havanensis Pfr. 1839, Archiv. f. Naturg. **5**, pt. 1, p. 354 (Cuba).

Records. Orange Creek; ½ mi. N. E. of Orange Creek.

VAGINULIDAE

Vaginula schivelyae bahamensis (Dall)

Veronicella schivelyae bahamensis Dall 1905, Smithsonian Misc. Collections **47**, pt. 4, p. 446, pl. 49, fig. 1 (Nassau and Little Abaco).

Very abundant in and around Arthurs Town and elsewhere on northern Cat Island. They are to be found under stones and trash during the day but appear exposed crawling at night or during rainy periods. Certain of the older natives told us that this species (referred to as "land curb")[1] was originally unknown on the island but it made its appearance when the Australian Pine was introduced. This, of course, may not be true, but it is also possible that commerce was responsible for its introduction. Our specimens agree with Dall's diagnosis, but it is still uncertain whether this subspecies may not be

[1] All chitons are referred to in the Bahamas as "sea curb" or just "curb" which is possibly a corruption of the word "curve." When chitons are removed from the rocks they coil like certain land isopods or "pill bugs." The Vaginulidae do this to a more limited extent, and this habit may have given rise to the use of this word.

identical with other West Indian forms. The entire family is in need of a careful revision.

Records. Arthurs Town.

SUCCINEIDAE

Succinea barbadensis Guilding

Succinea barbadensis Guilding 1828, Zoölogical Journal **3**, p. 532 (Barbados).

Rare, though fairly well distributed in northern Cat Island. Specimens were found mainly at the grass roots and around the base of stones.

Records. Arthurs Town; ½ mi. due E. of Arthurs Town; ½ mi. N. E. of Orange Creek; Blue Hole Hill.

PUPILLIDAE

Gastrocopta pellucida (Pfeiffer)

Pupa pellucida Pfr., 1841, Symbolae ad Hist. Hel. **1**, p. 46.

Found rather abundantly under stones and in soil pockets.

Records. Arthurs Town; ½ mi. N. E. of Arthurs Town; Blue Hole Hill; Little San Salvador and Goat Island, 1 mi. N. E. of Little San Salvador.

Pupoides modicus (Gould)

Pupa modica Gould 1848, Proc. Boston Soc. Nat. Hist. **3**, p. 40 (Florida).

Generally distributed on northern Cat Island but not so numerous as *Gastrocopta*.

Records. Arthurs Town; ½ mi. E. of Arthurs Town; Blue Hole Hill.

SUBULINIDAE

Subulina octona (Bruguiere)

Bulimus octonus Brug. 1792, Encycl. Meth. **1**, p. 325. (Gaudeloupe and Santo Domingo).

Records. Arthurs Town; ½ mi. due E. of Arthurs Town.

Opeas gracile (Hutton)

Bulimus gracilis Hutton 1834, Jour. Asiatic Soc. Bengal **3**, p. 93 (Mirzapur, Ceylon).

Records. Arthurs Town; 1½ mi. N. E. of Arthurs Town; Orange Creek.

Both *O. gracile* and *S. octona* are widely distributed in the Bahamas though not particularly abundant other than in a few localities. They prefer damp situations under stones, boards or palm fronds and appear to be more common in regions of human occupation.

OLEACINIDAE

Oleacinia (Laevoleacina) solidula (Pfeiffer)

Polyphemus solidula Pfeiffer 1840, Wiegm. Arch. **1**, p. 252 (near Matanzas, Cuba).

This species appears to be generally distributed throughout the Bahama Archipelago. It is rather secretive in habit, remaining for the most part under stones and debris, moving freely only during wet weather. It was not found abundant at any station.

In addition to its distribution in the Bahamas, it also occurs in Cuba and the Isle of Pines. Though it varies slightly in shape, the variation does not appear to be geographic, specimens from any one locality usually exhibit the variation range found in specimens from many different localities.

Records. Arthurs Town; ½ mi. due E. of Arthurs Town; Ridge 1½ mi. N. E. of Arthurs Town; ½ mi. N. E. of Orange Creek; Blue Hole Hill.

Pichardiella bahamensis (Bartsch)

Varicella gracillima bahamensis Bartsch 1913, Proc. United States Nat. Mus. **46**, p. 109, pl. 3, fig. 13 (Mangrove Cay, Andros Id., Bahamas).

Exceedingly rare and limited in distribution.

Record. Arthurs Town.

POLYGYRIDAE

Polygyra plana (Dunker)

Helix plana Dunker 1843, Abbildungen Neuer Conchylien, Cassel, **1**, p. 51, Helix, pl. 3, fig. 11 (? West Indies).

Polygyra plana bahamensis Vanatta 1919, Nautilus **33**, p. 72 (Current Settlement, Eleuthera, Bahamas).

(For a complete list of references and synonyms of the species, see Vanatta, E. G., 1910, Proc. Acad. Nat. Sci. Phila. **62**, p. 664.)

I am unable to separate *P. plana bahamensis* Vanatta from the typical form, originally described from Bermuda (see Vanatta, above). Several topotypes of Vanatta's variety (part of the same series collected by C. J. Maynard in 1897) were examined and the differences stated by Vanatta were not at all consistent. Several specimens were cut back without finding the parietal lamina mentioned for the Bahama form. There is no question but that it probably exists in certain specimens, but in the present case appears to be rare. It would seem to be a physiological character, a predisposition of certain specimens to produce the parietal tooth during its early development, which under normal conditions, is not developed until the animal has reached its growth morphologically. In this way, a low ridge or lamina, is produced along the parietal wall as the shell grows forwards. In most specimens this does not occur until the shell is fully grown, and results only in a rather large parietal tooth. It also appears in some specimens as a discontinuous lamina, appearing for a portion of a whorl only. This same condition exists in certain of the southern Florida Polygyras, a few specimens from the same locality possessing this lamina and not found at all in others.

Ecologically, this species prefers damp situations, usually under palm fronds, palm logs and stones. We did not find it at all on the high and dry portions of the ridges behind Arthurs Town. Certain equivalent species in Florida are found climbing grass and other low herbage, even in the salt marsh area. We found it very abundant at a few stations.

Records. Arthurs Town; ½ and 1½ mi. N. E. of Arthurs Town; ½ mi. N. E. of Orange Creek.

SAGDIDAE

Hojeda inaguensis (Weinland)

Helix inaguensis Weinl. 1880, Jahr. Deut. Malak. Gesel. **7**, p. 369, pl. 12, fig. 22 (Little Inagua).

Rare and limited to the ridges.

Records. Blue Hole Hill, 2 mi. N. N. E. of Orange Creek.

Lacteoluna selenina (Gould)

Helix selenina Gould 1848, Proc. Boston Soc. Nat. Hist. **3**, p. 38 (Georgia and Florida).

Well distributed in northern Cat Island but rare at any one place.

This species prefers the underside of stones. Live specimens possess a very coarse and ragged periostracum which is quickly lost when the mollusk dies.

Records. Arthurs Town; ½ mi. E. of Arthurs Town; Blue Hole Hill; Port Howe.

CERIONIDAE

Cerion, the only recent genus in this family, is probably one of the most remarkable ecologically among the land pulmonate gastropods of the West Indies. Other than in the Bahamas and Curacao, it is to be found only in the immediate vicinity of the sea. This ecological condition is not to be confused with the habit of most genera in the family Ellobiidae which are to be found in a salt or a brackish swamp area. *Cerion* are not found in a "salt marsh" or "mangrove" association or with any type of swamp or normally wet situation, but are found on dry soil or rocky land above and beyond the high watermark. In wooded areas they are semi-arboreal, climbing the trees, sometimes to a considerable height, but usually within fifteen feet of the ground. Elsewhere they will be found on bushes, cacti, grass and stones, and even under stones if plant cover is at all scarce. In Cuba, *Cerion* is usually found from the upper limit of the shore to about 500 feet inland, seldom more. In the Bahamas, they may be found a few miles inland, which is probably due to the greater distance that the salt spray can be carried in these generally and comparatively flat islands or to the presence of inland brackish water areas. We are unable to say just what the limiting factor is, i.e. the existence of salt in the form of dried spray, or lichens upon which they feed which may be peculiar to the same region. It would appear to be the former, to judge entirely by the fact that they will feed on other substances such as wafer fish food and even paper, if sufficient moisture is present to keep them active.

According to Dall (1905, p. 30) the genus *Cerion* dates from the Oligocene and at that time definitely occupied a group of islets which now form a part of the north central portion of Florida. The genus probably occurred at this time in Cuba and perhaps elsewhere in the Greater Antillean region, though as yet no fossil species have been found earlier than the Pleistocene in this area as far as I can determine.

The extraordinary complexity of this genus is due apparently to two very important factors, the relative instability of most of its characters and that of a colonial habit. These factors can be enlarged upon as follows:

Variability. All of the general characters in *Cerion* are subject to considerable variation, that is, the presence or absence of color, being ribbed or smooth, having an open or closed umbilical area, having a great difference in size and having the lip built forwards, thickened or back folded. To these characters there can be added the variation in the position, length and size of the apertural teeth, the presence or absence of minute sculpture and the variation in shape. With such a large number of variable characters the differentiation possible is almost endless.

Colonial habit. The most important factor, however, appears to us to be the colonial habit, a condition that is exceedingly rare in mollusks. This is not to be confused with colonies of any one species of mollusks that are limited by the nature of their environment to occupy any particular area. Cerion will group themselves into large or small colonies within an ecological territory which is much larger than the area that the colony will occupy. Upon field evidence these colonies will migrate from one part of an area to another. Migration may be exceedingly slow, a matter of years to cover a distance of a mile. This migration habit associated with their definite colonial existence has probably been responsible for the very great complexity of the genus. Individuals in a single colony resemble one another more closely *in the mass* than they do individuals of another colony. Certain individuals of any one colony in a species may approximate or exactly duplicate individuals of another colony. Even distinct colonies may be very close in their mass characteristics, though exact colonial duplication is practically unknown. This factor then may prove to be the underlying cause for the remarkable and extraordinary variation, as the colonial habit produces periods of isolation during which certain of the characters become fused through the unit population, the migrating tendency eventually brings about a union of two or more colonies with a consequent mixing of the colonial characters, the result usually being an astounding number of individual variants. Mechanical mixing by means of hurricanes is exceedingly difficult to prove, but the potential factor in the habitat situations occupied by these mollusks is certainly present for such a mode of dispersal. They cling to dead palm fronds, bark and other vegetation subject to mechanical transport and in certain cases are held temporarily captive in the pinnate leaflets of the coconut and palmetto fronds. In such a manner they could be readily transported by the caprice of any hurricane to a new situation. A striking relationship, which is possibly of this type, is that between *Cerion huntingtoni* (new) of Cat Island and *C. fairchildi*

Cl. of Conception Island. The two species are very close to some common ancestral stock not far removed in the past. The depths of the ocean between Cat Island and Conception are great (741 fathoms) and it doesn't seem possible that such a relationship would date from the time that these islands were connected, if such a connection ever did exist. Conception Island lies about 25 miles S. E. of Columbus Point, the nearest part of Cat Island, and the type locality for *C. huntingtoni*. Mechanical distribution either one way or the other does not seem impossible between these two islands.

As reiterated elsewhere, hurricanes have probably played an important part in the present distribution of the Bahama mollusks and perhaps other faunistic elements on these islands. As the Bahama Cerions generally are arboreal (limited, however, to the lower parts of trees and bushes) aerial distribution at such a time is not only possible but highly probable.

The distribution of *Cerion* within limited areas is not necessarily continuous. Perhaps one of the most important facts to be borne in mind is the strong colonial segregation exhibited by the many species. Just what limits the area of each colony is not always clear. Many times physical barriers are evident and the margins of each colony are delimited by salt pans, bare rock, marsh land, or lack of suitable plant life. On the other hand, colonies are to be met that are limited in area with no definable barriers to restrict their distribution beyond the known boundaries of such a colony. Such colonies may be new and are now slowly enlarging their present boundaries. It is quite possible, of course, that other barrier factors not apparent may be present. In regard to this last statement, many times during field work, mainly in Cuba, dead shells of a particular species will be encountered in considerable numbers in a region with no living examples of the species available. A few hundred feet to several kilometers away the same species may be found living in countless numbers. This is particularly true for species that exhibit a definite colonial organization. More evenly distributed species show a distributional pattern that coincides with a particular type of habitat or else limited by some physical barrier. Their individual migrations are not directional as a colonial unit, but they tend to dispose themselves more or less evenly throughout a given type of ecological territory.

It now appears among the Cerionidae that the greater the isolation, the greater the uniformity among the individuals of a colony. Both *C. utowana* and *C. greenwayi*, the first from East Plana Cay, the second from Atwoods Cay, exhibit a remarkable degree of uniformity

among all the individuals obtained from these two well isolated islands. The same is true of *C. fairchildi* from Conception Island. On the other hand, species occurring on the larger islands where many colonies of several species or races occur, tend to be extraordinarily variable. Here, a mixture of colonies is possible by both migration and mechanical distribution which results in a fusion of all the individual characters possessed by the colonies that are mixed.

Section Strophiops[1]

Cerion felis Pilsbry & Vanatta

Plate 1, fig. 1–4

Cerion (*Maynardia*) *felis* P. & V. 1895, Proc. Acad. Nat. Sci. Phila. p. 206 (Cat Island).

Cerion felis P. & V. 1896, Proc. Acad. Nat. Sci. Phila. p. 322, pl. 11, fig. 29; H. A. Pilsbry 1902, Man. of Conch. (2) **14**, p. 221, pl. 44, fig. 72–73.

This species was described from a single specimen with the locality only as Cat Island, originally received from T. Bland. Williams collected a very large series of this species from near Turtle Cove, 4 mi. N. N. E. of The Bight, Cat Island. It is a species of the exposed eastern side of the island.

Many specimens exhibit considerable irregularity in the production of the whorls, these being offset either above or below a normal whorl. In a few specimens the upper three or four whorls are tipped over at a slight angle as though the early whorls had been broken from the rest and then cemented together again, the repairing being poorly executed.

A few additional measurements are given to supplement that of the holotype (A.N.S.P.).

Length	Width	Whorls	
28.	11.5 mm.	10.5	Holotype (A.N.S.P.)
30.8	11.	11.	Topotype
30.7	11.2	10.	"
30.9	12.6	10.5	"
28.5	12.5	10.	"
32.5	12.3	11.	"

Several specimens from this place agree with the holotype in size, shape and in the number of whorls so that Turtle Cove can be considered the type locality.

[1] All Cerions from Cat Island are members of this section.

Cerion huntingtoni, new species

Plate 3, fig. 1–3

Description. Shell subcylindrical, stout, solid, with the umbilical rimation closed or only minutely open. External color a chalk-white with the interior of the aperture a pale, creamy brown. Whorls 9½ to 10½, last three, somewhat flattened, remaining earlier whorls sharply tapering to an obtuse summit. Spire somewhat short, conic, and slightly convex, produced at an angle of 83° (holotype).[1] Aperture subovate to nearly circular. Parietal tooth strongly developed, centrally located and about three times as long as high. Columellar lamella much smaller but carried back for a full whorl. Lip expanded, flattened and generally recurved. Parietal lip well thickened, usually enough to connect the insertion points of the palatal lip. Suture well defined, sharply though not deeply indented. Sculpture generally of strong and widely spaced ribs, variable in number (18–23) and occasionally nearly obsolete. Nuclear whorls (1½) smooth. Basal ridge inconspicuous, the ribs continuing into the umbilical rimation.

Length	*Width*	*Aperture*	
30.5	13.5	8.5 x 6.7 mm.	Holotype
25.5	13.2	7.5 x 6.5	Smallest
31.3	13.	8. x 6.5	Largest
28.8	13.6	8.2 x 6.6	Average of 10 specimens

Holotype. Mus. Comp. Zoöl. no. 106956, Columbus Point, S. E. tip of Cat Island, Bahamas, E. Williams collector, July, 1935. Paratypes (2000±) from the same locality.

Remarks. This species is materially different from all others encountered on this island and the only species of the *regina* group known to occur on Cat Island. In relationship, it appears to be closely related to *C. fairchildi* Clench from Conception Island which is located about 25 miles S. E. of Columbus Point. It differs from that species in being a little smaller, more coarsely ribbed, has a less produced spire and a very much darker coloration within the aperture. A single colony only of this species was collected.

Cerion glans (Kuster)

Pupa glans Kuster 1844, Conchy.-Cab. **1**, pt. 15, p. 74, pl. 11, fig. 1–2 (Locality unknown) [Nassau, New Providence, Pilsbry 1902, p. 260].

All of the localities from which specimens of this widely distributed Bahama Cerion were obtained are located near the central portion of

[1] A series of 10 specimens, however, gave a variation of this angle from 73° to 85°.

Cat Island. They occurred usually on the outer coastal strip. The specimens collected are a little more mottled than typical *glans* of New Providence, the remaining characters are similar.

Records. Bachalar; Knowles; 1 mi. E. of Hollywood; 3 mi. E. of Smith Town; Old Bight; Turtle Cove Settlement.

Cerion (strophiops) liliorum, new species

Plate 2, fig. 2–4

Description. Shell cylindrical, solid, ribbed, tapering and rimately perforated. Color white to dull grayish brown. On colored shells the ribs are generally white. Interior of aperture a pale brownish cream. Whorls 10½ to 11, the first full whorl smooth and opaque white, the remaining whorls strongly ribbed. Generally the first 6 whorls form a fairly acute cone to the spire, the remaining later whorls more or less parallel sided. Spire produced at an angle of 78°. Aperture subcircular. Parietal tooth centered, fairly high but not long. Columellar tooth situated low, not very high but carried backwards for a full whorl giving a twisted appearance to the columella within. Lip full and beveled, built slightly forwards and forming a parietal ridge. Sculpture of somewhat coarse and numerous, slightly irregular ribs with about 23–26 on the body whorl.

Length	*Width*	*Aperture*	
32.0	14.0	8.1 x 6.8 mm.	Holotype
31.2	13.3	7.5 x 6.0	Paratype
30.9	14.0	7.8 x 6.2	"
30.7	14.2	8.0 x 5.8	"
32.3	13.3	8.0 x 6.1	"
28.3	13.1	7.5 x 5.5	"
29.2	12.1	7.2 x 6.5	"
28.5	13.5	7.5 x 6.0	"
28.0	13.1	7.8 x 5.5	"
25.6	12.5	6.8 x 5.5	"

Holotype. Mus. Comp. Zoöl. no. 116086, Next Point, (east coast) 1½ miles E. N. E. of Governors Harbour, Eleuthera Island, Bahama Islands. W. J. Clench collector, May, 1936.

Remarks. Specimens of this species were first collected on Little San Salvador Island in 1935, but they were rare and only a limited series was obtained. For this reason, Eleuthera Island is taken as the type locality for the species inasmuch as a very extensive series is at hand for study. These were collected at several localities in 1936, all

along the outer or eastern shore of Eleuthera, all places within a few miles of Governors Harbour.

This species is a member of the *Cerion glans* group as outlined by Pilsbry (1902, p. 249). From typical *glans* it differs in being somewhat larger, proportionately heavier and possesses a well formed perietal ridge. From *C. glans coryi* Mayn. it differs in being much lighter in color, larger and heavier. The umbilical rimation in *liliorum* is longer and generally with a very small perforation. Both possess the strong parietal ridge.

We found specimens most abundant on the wild spider lilies along the exposed eastern shore of Eleuthera. On Little San Salvador they occurred on a small patch of these lilies on the north side of this small island. It did not occur on Cat Island.

Cerion (strophiops) russelli, new species

Plate 1, fig. 5–8

Description. Shell cylindrical, rather elongated, strong but not solid, coarsely ribbed and usually minutely perforated. Color dull greyish brown, rarely mottled. Whorls 10 to 11, first 1½ smooth, remainder ribbed, fine and numerous at first, then becoming coarse and heavy and rather widely spaced on the later whrols. Spire acute, the cone of about 7 whorls, remaining whorls more or less parallel sided. Cone of spire forming an angle of 74° (holotype). Aperture subovate. Parietal tooth short and not very high. Columellar tooth small and follows within for about one whorl. Lip reflected, rather flat, rarely thickened or back folded. Parietal ridge well developed. Suture well defined and slightly indented. Umbilical perforation small and usually present. No pronounced basal ridge. Sculpture of numerous and strong ribs, with widely spaced intervals variable but usually 1½ to 2 mm. apart, and numbering 18 to 20 on the body whorl. A few specimens possessed fine spiral incised lines.

Length	*Width*	*Aperture*	
32.8	13.5	8.2 x 7 mm.	Holotype
32.7	13.5	8.3 x 6	Paratype
31.5	13.7	9. x 6.8	"
32.	13.2	8. x 6.5	"
32.4	13.8	8.5 x 7.	"
31.	13.7	8.5 x 7.5	"
30.	13.3	8. x 6.	"
27.7	12.5	7.2 x 5.5	"
27.3	13.6	8. x 7.	"
26.6	14.	7. x 6.5	"

Holotype. Mus. Comp. Zoöl. no. 107534, near Turtle Cove, 4 mi. N.N.E. of The Bight, Central Cat Island, Bahama Islands. E. Williams collector, July, 1935.

Remarks. This species appears to be an aberrant form in the *glans* group though it is somewhat intermediate between this group and that of *Cerion felis* P. & V. There appears to be no question but that certain specimens are hybrids between this form and *felis*. Colonies of both were found in the same general area, on the windward side of the island.

From *C. glans, C. russelli* differs by being very much larger, proportionately thinner and in having a flatter, non back folded lip. Only a single colony of this form was obtained on Cat Island and its specific relationships are not clear.

Cerion fordii Pils. & Van.

Cerion fordii Pils. & Van. 1897, Proc. Acad. Nat. Sci. Phila. p. 365, text fig. 1–2 (Bahamas).

Cerion fordii submarmoratum Pils. & Van. 1897, Proc. Acad. Nat. Sci. Phila. p. 365, text fig. 3–4 (Bahamas).

The exact locality of this species is still unknown. It appears to be close to *C. eximium* and in all probability occurs on Cat Island, possibly in the southern portion of the island. The variety *submarmoratum* does not seem to us to constitute a valid form, it differs but slightly from *fordii* P. & V. but not nearly as much as certain colonial elements in *eximium*. Plate (1907, p. 608) referred specimens that he had collected on Cat Island to this species, but they proved upon later examination to be a new form. This was described as *platei* (q.v.).

Cerion platei Clench

Cerion (*Strophiops*) *platei* Clench 1933, Proc. New England Zoölogical Club **13,** p. 90, pl. 1, fig. 7–8 (Bight Road, Cat Island, Bahamas).

This species appears to be limited to the lower and east coastal region of the island. It seems to be fairly close in its relationships to *eximium* Mayn. differing particularly in the remarkable development in the collared or back-folded lip.

Records. Old Bight; Middle Bight; Devil Point (L. Plate, as *C. fordii*).

Cerion eximium (Maynard)

Plate 3, fig. 4–8

Strophia eximea Maynard 1894, Contributions to Science **2,** p. 177, fig. 59a–b, 61a–c (Cat Island).

Cerion eximium, Pilsbry 1902, Man. of Conch. (2), **14**, p. 265, pl. 38, fig. 76–78; Pilsbry 1896, Proc. Acad. Nat. Sci. Phila. p. 326; Dall, W. H., 1905, [in] The Bahama Islands, Geographical Society of Baltimore, p. 41; Maynard, C. J. 1920, Records of Walks and Talks with Nature, appendix, **10**, p. 126, pl. 10, fig. 1–2.

Maynard (1894, p. 179) received his specimens of *C. eximium* from a Mr. Curtiss of Nassau who in turn had received them from a native of Cat Island. Specimens of the type series are identical to those of Arthurs Town and probably originally came from there. This place can be considered the type locality.

This is by far the most abundant species of *Cerion* found on northern Cat Island. It existed in many diverse types of habitats, though it was absent from the higher ridges. It did not occupy the extreme outer or eastern coastal strip but did occur a short distance behind. As far as we are able to ascertain, all members of this group in the Bahamas, such as *eximium* (Cat, Long and Eleuthera Islands); *agrestinum* (New Providence), *bendalli* (Gt. Abaco), etc. do not frequent the exposed outer sides of these islands, though rarely they may exist a short distance behind the sandy ridge or rocks along the shore. The extreme outer area usually possesses an entirely different assemblage of Cerions if any members of the genus are present at all.

Cerion eximium is a polymorphic species, occurring as smooth, costate, mottled or white. Extreme forms exist as smooth-white; smooth-mottled; costate-white and costate-mottled. These four types possess all of the possible intergradations.

About half of the colonies of this species were found to consist of very similar specimens, the remainder showed a little to a great deal of variation. Generally, the isolated colonies, protected by minor barriers exhibited the greatest uniformity both as to the morphological structure of the shell and the degree and type of coloration.

The distribution of smooth, mixed and costate colonies, however, was not irregular. The few smooth colonies were all found on the lee coast near the sea; the costate forms along the lee coast and again behind the outer rampart along the windward coast. The mixed colonies occurred both on the lee and windward coast and at several places in the interior. We have seen no specimens of *eximium*, even near the outer or windward coast, at any place other than northern Cat Island. Also, in an extensive series of *eximium* from Eleuthera and Long Island, no colonies exhibited the wide range of colonial variation nor the strongly costate forms exhibited by the series from northern Cat Island. Our only explanation is that the ecology of the region may

be a factor in some way responsible for the development of these strongly costate examples. There are many other species of *Cerion*, perfectly smooth, that live along the exposed coasts of these islands, and elsewhere, such as in Cuba, so that it is evident that ecology alone is not a controlling factor, though it may be a force of some extent with certain species. It is of value to note that *C. johnsoni* and *scalarinum* Pfr. (Cuba), *felis* (Cat Island) and *steavensoni* (Long Island) all live close to salt water along the exposed sides of these islands and they are the most costate and rough species known.

The following localities are those from which we obtained the several colonies of *C. eximium* on northern Cat Island. They are grouped according to their structure of being smooth, costate or occurring together in a colony of both smooth and costate individuals.

Smooth

Wilson Bay; Bennetts Harbour; The Lot; Rock Cay, Bennetts Harbour.

Costate

Anguilla; 3 mi. S. of North East Point; Coarsand; Dumfries; Zion Hill; False Creek; Smoky Point; south side of Smoky Point Lake; between Orange Creek and Port Royal; Wilson Bay.

Smooth and Costate Forms

Barrataria; Winding Bay; Fountain Hill; Bat Hole; Grape Point; Zingo Hill; Laurimore; Orange Creek; North End Point; Mt. Pleasant; Arthurs Town; North East Point; near Rock Point, Bennetts Harbour; Stormy Battle.

Cerion eximium fraternum Pilsbry

Cerion eximium fraternum Pilsbry 1902, Man. of Conch. (2), **14**, p. 265, pl. 38, fig. 79–80 (San Salvador, ex. Bland); Dall, W. H., 1905, [in] The Bahama Islands, The Geographic Soc. Baltimore, p. 41.

This is a diminutive race of *Cerion eximium* and apparently quite rare. We did not find it on northern Cat Island, though it occurred sparingly on Little San Salvador. A few specimens found at this latter locality are hybrids, between *fraternum* and *liliorum*.

The exact type locality is unknown but as Bland had received other species of Cat Island material from near the center of the island, it is quite probable that his *fraternum* material came from the same area.

The type lot described by Pilsbry was in the Swift collection, originally supplied by T. Bland. The original collector was H. Bryant, who had collected at The Bight, San Salvador during a trip to Gt. Inagua in 1866.

UROCOPTIDAE

Members of this family occurring in the Bahamas are all more or less cryptic in habit, seeking protection under stones or in the plant debris of the solution holes, usually on the tops of the weathered limestone blocks. All of the species are found most abundantly in the rocky areas upon the higher portions of the islands. Most species in this family, particularly in Cuba, are to be found in exposed situations, though a limited number of forms occupy the same ecological station.

Urocoptis bahamensis providentia Pilsbry

Urocoptis bahamensis providentia Pils. 1903, Man. of Conch. (2) **15**, p. 280, pl. 65, fig. 21–22 (Nassau, New Providence).

This is a rather widely distributed species in the Bahamas, occurring on the Abaco Islands on the Little Bahama Bank and most of the large islands of the Great Bahama Bank. So far, only Mariguana possesses this species among the isolated islands of the southeast.

It seems questionable whether this form should be separated subspecifically from *Urocoptis bahamensis* Pfr. The typical species is only slightly smaller, other characters are identical. Pfeiffer described his specimens of the typical species from Nassau, receiving them originally from Poey and it is possible that they came from a locality that has subsequently been destroyed as no others quite as small have been collected since on New Providence.

Records. Near Arthurs Town; 1½ mi. N. E. of Arthurs Town; Blue Hole Hill.

Microceramus providentia Pilsbry

Microceramus gossei providentia Pils. 1904, Man. of Conch. (2) **16**, p. 161, pl. 26, fig. 16 (Nassau, New Providence).

Widely distributed on the northern Bahamas, usually more abundant than *Urocoptis*. It is found in the same habitat.

Records. Arthurs Town; ½ mi. and 1½ mi. N. E. of Arthurs Town; Blue Hole Hill.

Microceramus russelli Clench

Microceramus russelli Clench 1937, Proc. New England Zoöl. Club **16**, p. 63, pl. 3, fig. 4–5 (Blue Hole Hill, 2 mi. N. E. of Orange Creek, Cat Island).

A much rarer form than the last and known only to occur on Cat, Long and Mariguana Islands.

Records. Arthurs Town; Blue Hole Hill.

CEPOLIDAE

Hemitrochus varians (Menke)

Helix varians Menke 1829, Conch.-Samml. Malsburg, p. 5.
Helix (*Hemitrochus*) *varians*, Pilsbry 1889, Man. Conch. (2) **5**, p. 24, pl. 13, fig. 59–63.

This is the most abundant, and widely distributed, land mollusk on Cat Island. It is to be found nearly everywhere above high water line from the low coastal areas to the tops of the central ridges of the island. It is usually rare in the thick vegetation, preferring somewhat open exposed areas. It lives on bushes and small scrub growth, showing a decided preference for the spider lilies that are found along the sandy ridge on the outer northeast side of the island.

Band coloration in this species is exceedingly complicated in addition to a complex ground color plan. No studies as yet have been made to see if certain color groups have any geographical significance on the islands. It would also appear that in certain localities this species will hybridize with *H. troscheli brownii* Pils., the only other *Hemitrochus* on Cat Island. Elsewhere on the island these two forms apparently intermingle without crossing.

H. varians is not a true colonial land mollusk. Its abundance in any one place is apparently due to conditions best adapted for the species. Its absence from suitable areas is generally due to recent fires, as the dead and charred "bones" are in evidence nearly everywhere in such stations.

Records. The following are only a few of the many places at which the species was obtained. Stations are included that were made by the "Utowana" on the 1934 trip as well as those made by M. Williams and others. This species, curiously enough, was not heretofore recorded for Cat Island.

Hawksnest Point (Barbour & Greenway); Baintown, 3 mi. N. W. of Port Howe; Columbus Point; Turtle Cove, 4 mi. N. N. E. of The

Bight (all southern and central Cat Island); Arthurs Town; Orange Creek; Rock Cay; Bennetts Harbour; North End Point (all northern Cat Island). Little San Salvador.

Hemitrochus troscheli brownii Pilsbry

Helix (*Hemitrochus*) *troscheli brownii* Pilsbry 1889, Man. of Conch. (2) **5**, p. 29, pl. 31, fig. 27. (Cat Island, Bahamas).

So far as known, this subspecies of *troscheli* is confined to Cat Island. Pilsbry (loc. cit.) has emphasized its carinated condition though this, as well as other characters, varies considerably and many specimens would certainly fit the characters of *H. troscheli* proper.

It is not as common as *H. varians*, neither in distribution nor the abundance of individuals at any one station.

Records. Cat Island (J. J. Brown), [These were probably collected near The Bight in the central part of the island.] Anguilla Flat, 2 mi. N. E. of Arthurs Town; Bat Hole and White Pond, about 2½ mi. N. E. of Orange Creek; Bain Town, 3 mi. N. W. of Port Howe, southern Cat Island.

Plagioptycha duclosiana salvatoris (Pfeiffer)

Helix salvatoris Pfeiffer 1867, Malak. Blätt. **14**, p. 127 (Bight of San Salvador, Bahamas).

Helix (*Plagioptycha*) *duclosiana salvatoris*, Pilsbry 1889, Man. of Conch. (2), **5**, p. 19, pl. 11, fig. 13–15.

Widely distributed on Cat Island. It seldom appears in any great numbers, but during dry weather several specimens will collect at one point, such as under a piece of loose bark or under the leaves of vines that cling to the tree trunks. Under more unfavorable conditions a few specimens will be found secreted under loose stones. This appears to be a very good subspecies, differing quite constantly from the typical form by its lengthened apertural tooth which, in addition, is situated nearer to the lower margin of the lip. There is, however, some variation.

Records. Bight of San Salvador (Pfeiffer); Cat Island (Dall), a few records only are given as it was collected at nearly all stations visited. Arthurs Town; Smoky Point Lake, 4 mi. E. of Arthurs Town; Grape Point, 5½ mi. N. of Arthurs Town; North End Point, 5 mi. N. W. of Arthurs Town; Roker Settlement, 9 mi. S. E. of Arthurs Town.

SPHAERIIDAE

Byssanodonta bahamensis, new species

Plate 2, fig 6

Description. Shell small, inequilateral, transversely-oblong, moderately compressed. Beaks prominent but not particularly full. Anterior end short and rounded, posterior end much broader, rounded but terminating above at a rather straight hinge line. Color a dull brownish yellow, mottled with black over the disk. Sculpture of very fine concentric ridges. Rest stages indicated by a sharply raised ridge.

Length	*Height*	*Width*	
5.7	4.6	3. mm.	Holotype
6.5	5.2	3.2	Paratype

Holotype. Mus. Comp. Zoöl. no. 107726, ½ mi. due east of Arthurs Town, Cat Island, Bahama Islands. Clench, Russell, Huntington collectors, July, 1935. Paratypes from the above locality and from ½ mi. N. E. of Orange Creek.

Remarks. This is the first recorded species in the family Sphaeriidae from the Bahamas. It is closely allied to *B. cubensis* (Prime), but differs in several rather consistent minor characters. The present new form is more compressed with the beaks less full and the anterior area shorter. The sculpture of *B. bahamensis* is coarser, but this character may possibly vary with habitat conditions.

The specimens were all dead when found, mixed with the damp earth of partly dried up "aguadas" in the swamp land back of Arthurs Town and again at Orange Creek. It was not at all abundant at the localities collected. Mr. Greenway and I collected it at West End, Grand Bahama Island in April, 1936.

Relationships of the Cat Island Mollusks

Thirty-eight species and subspecies are listed above for this island.[1] Additions, of course, are to be expected when the lower part of the island is more fully explored, but the number added, however, will probably not be great. Certain of these, such as *Truncatella, Pedipes* and other Ellobiids which we did not find, are generally distributed throughout the West Indies and will add nothing to the immediate problem of origin.

Of the 38 forms, 17 occur elsewhere in the Bahamas (4 of these also extend their range to the Bermudas, Florida and Cuba) and 13 others

[1] *Cerion liliorum*, the thirty-ninth, is not known from Cat Island but is limited to Little San Salvador and Eleuthera.

are of general distribution in the West Indies and beyond. The remaining 8 species and subspecies are endemic and are closely allied to forms existing elsewhere in the Bahamas, all but 2 are *Cerion*.

Eliminating the species that are widely distributed in the Bahamas and the West Indies proper, there are but 11 that are endemic or of limited distribution outside of Cat Island. Of the non-endemic species, *Alcadia fallax* occurs elsewhere only on the island of New Providence, *Microceramus russelli* on Long and Mariguana islands and *Byssanodonta bahamensis* on the island of Grand Bahama.

The relationship of the endemic forms to others are as follows: *Cerion felis* to *C. stevensoni* of Long Island; *C. huntingtoni* to *C. fairchildi* of Conception Island; *C. russelli* to the *glans* group of Cerions of wide distribution in the Bahamas; *C. fordii, C. platei* and *C. eximium fraternum* to members of the *martensi* group also of wide distribution in the islands. The two remaining endemics, *Hemitrochus troscheli brownii* and *Opisthosiphon bahamense insulae-felis,* are subspecies of wide ranging Bahaman forms.

It is to be seen from the above that the diverse origin of the molluskan fauna of this single island parallels the condition that exists for the Bahamas as an island group. Any previous land connection with the Great Bahama Bank would necessarily have been by way of Eleuthera, over what is now the submerged ridge that joins these two islands. Yet it is surprising that the restricted and really critical species should only occur on distant islands and not on Eleuthera. The same is equally true for the relationships of certain of the endemic forms.

I would infer from this evidence that at least a portion of the mollusk fauna is fortuitous, and that the mechanical agencies responsible for the original Bahaman fauna have also aided in populating Cat Island.

Echinoderms

Determined by H. L. Clark

ASTEROIDEA

**Luidia alternata* Say[1]
Oreaster reticulatus (L.)
Linckia guildingii Gray
Echinaster sentus (Say)

[1] Species marked with an asterisk are recorded from the Bahamas for the first time. All are from Arthurs Town.

OPHIUROIDEA

Ophiothrix oerstedii Ltk.
Ophionereis reticulata (Say)
Ophiocoma echinata (Lam.)
Ophiocoma pumila Ltk.
Ophiocoma riisei Ltk.
Ophioderma appressum (Say)
Ophioderma brevicaudum Ltk.

ECHINOIDEA

Tripneustes esculentus (Leske)
Echinometra lucunter (L.)
**Echinometra viridis* A. Ag.
Clypeaster rosaceus (L.)
Mellita sexiesperforata (Leske)
**Echinoneus cyclostomus* Leske
Brissus brissus (Leske)

HOLOTHURIOIDEA

Thyone surinamensis Semper
Holothuria floridana Pourtales
Holothuria impatiens (Forskål)

List of Cat Island Reptiles and Amphibians
Determinations by T. Barbour and B. Shreve[1]

Epicrates striatus strigilatus (Cope)
Tropidophis pardalis barbouri Bailey
(Utowana Exp., 1931–1932)
Alsophis vudii vudii Cope
Sphaerodactylus decoratus Garman
Sphaerodactylus notatus Baird
Anolis distichus Cope
Anolis ordinatus Cope (Utowana Exp., 1934)
also Little San Salvador and Goat Cay
near northern Cat Island
Anolis smaragdinus Barbour and Shreve

[1] All of the listed species were collected by the 1935 expedition, with records of earlier collectors added.

Leiocephalus carinatus virescens Stejneger, also Goat Cay, northern Cat Island
Ameiva thoracica Cope (Utowana Exp., 1934), also Little San Salvador, northern Cat Island
Pseudemys felis Barbour (W. G. Albury and C. S. Dolley)
Hyla septentrionalis Boulenger (Utowana Exp., 1931–1932)
Eleutherodactylus ricordii (Duméril and Bibron)

BIBLIOGRAPHY

Agassiz, Alexander

1894. A Reconnaissance of the Bahamas and of the Elevated Reefs of Cuba in the Steam Yacht "Wild Duck" January to April 1893. Bull. Mus. Comp. Zoöl. **26**, no. 1, pp. 1–203, 47 plates.

Allen, Glover M.

1937. Geocapromys Remains from Exuma Island. Journ. of Mammalogy, **18**, no. 3, pp. 369–370.

Barbour, Thomas

1937. Third List of Antillean Reptiles and Amphibians. Bull. Mus. Comp. Zoöl., **82**, no. 2, pp. 77–166.

Bland, Thomas

1873. On the Physical Geography of, and the Distribution of Terrestrial Mollusca in, the Bahama Islands. Ann. Lyc. Nat. Hist. New York, **10**, pp. 311–324.

Bond, James

1934. The Distribution of the West Indian Avifauna. Proc. American Phil. Soc., **73**, pp. 341–349.

Catesby, M.

1731. The Natural History of Carolina, Florida and the Bahama Islands. London. **1**, pp. 44 + 100. 100 plates.

Clench, W. J. and R. A. McLean

1936. Marine Bivalves Collected by the Harvard-Bahama Expedition of 1935. Mem. Soc. Cubana Hist. Nat. **10**, pp. 157–168.

1937. Marine Bivalves from Little and Great Abaco, Grand Bahama and Eleuthera, Bahama Islands. Mem. Soc. Cubana Hist. Nat. **11**, pp. 31–42.

Clench, W. J.

1933. Notes and Descriptions of Land Mollusks from the Bahama Islands, Based Mainly upon Collections Obtained During the Utowana Expeditions of 1932 and 1933. Proc. New England Zool. Club **13**, pp. 77–100, pl. 1.

1934. Notes and Descriptions of New Cerions from Hispaniola and the Bahama Islands, Based Mainly upon Collections Obtained During the Utowana Expedition of 1934. Proc. Boston Soc. Nat. Hist., **40**, pp. 205–218, pl. 1–2.

1937. Shells of Mariguana Island, with a Review of the Bahama Helicinidae and Descriptions of New Bahama Species. Proc. New England Zoöl. Club, **16**, pp. 57–79, pl. 3.

Dall, W. H.

1894. Cruise of the Steam Yacht "Wild Duck" in the Bahamas, January to April, 1893, in charge of Alexander Agassiz. Pt. 2. Notes on the Shells Collected. Bull. Mus. Comp. Zoöl. **25**, no. 9, 113–124, 1 plate.

1905. Report on Land and Freshwater Shells Collected in the Bahamas in 1904 by Mr. Owen Bryant and Others. Smithsonian Misc. Collections, **47**, pt. 4, pp. 433–452, pl. 48–49.

Daly, R. A.

1934. The Changing World of the Ice Age. Yale Univ. Press. New Haven, 1934, pp. 19 + 271. 149 text figures.

Field, R. M. (with collaborators, Miner, Dahlgren and Dixon)

1931. Geology of the Bahamas. Bull. Geological Soc. America **42**, pp. 759–784, pl. 18–21.

Greenway, J. C.

1938. Flight Over the Bahamas. Harvard Alumni Bulletin, **40**, no. 15, pp. 483–488, 2 text figures.

Griscom, Ludlow

1926. The Ornithological Results of the Mason-Spinden Expedition to Yucatan—Pt. 2, Chinchorro Bank and Cozumel Island. American Mus. Nat. Hist. Novitates no. 236, pp. 1–13.

Gulick, Addison

1932. Biological Peculiarities of Oceanic Islands. The Quarterly Review of Biology, **7**, pp. 405–427.

Hesse, Richard, W. C. Allee and Karl P. Schmidt.

1937. Ecological Animal Geography. pp. 14 + 597. 135 text figures. John Wiley & Sons. New York.

Lawrence, B.

1934. New Geocapromys from the Bahamas. Occ. Pap. Boston Soc. Nat. Hist. **8**, pp. 189–196.

Matthew, W. D.

1915. Climate and Evolution. Ann. New York Acad. Sci. **24**, pp. 171–318.

Maynard, C. J.

1894. Contributions to Science, Newtonville, Mass., **2**, pt. 4, pp. 153–204.

1919–1926. Contributions to the History of the Cerionidae. Appendix to volume 10, Records of Walks and Talks with Nature. West Newton Mass., no. 1–12, pp. 1–242, pl. 1–43, 123 text figures.

McAtee, W. L.

1917. Showers of Organic Matter. Monthly Weather Review. **45**, pp. 217–224.

Moseley, Mary
1926. The Bahamas Handbook. The Nassau Guardian, Nassau, Bahamas. pp. 1–203, 32 plates, 4 maps.

Pearse, A. S.; E. P. Creaser; F. G. Hall
1936. The Cenotes of Yucatan, A Zoological and Hydrographic Survey. Carnegie Institution of Washington Publ. no. 457, pp. 1–304, 15 plates.

Pilsbry, H. A.
1902. Manual of Conchology (2), **14**. *Cerionidae*.

Richards, H. G.
1937. Land and Freshwater Mollusks from the Island of Cozumel, Mexico, and their Bearing on the Geological History of the Region. Proc. American Phil. Soc., **77**, pp. 249–262, 3 plates.

Sayles, R. W.
1931. Bermuda During the Ice Age. Proc. American Acad. Arts and Sciences, **66**, no. 11, pp. 381–486, pl. 1–13, 18 text figures.

Schuchert, C.
1935. Historical Geology of the Antillean-Caribbean Region. John Wiley & Sons, New York, pp. 26 + 811, 107 text fig. + 16 maps.

Shattuck, G. B.
1905. The Bahama Islands. The Geographical Society of Baltimore, The MacMillan Co., New York, pp. 32 + 630, 93 plates.

Simpson, C. T.
1894. Distribution of the Land and Fresh-Water Mollusks of the West-Indian Region, and Their Evidence with Regard to Past Changes of Land and Sea. Proc. United States Nat. Mus. **17**, pp. 423–450.

Wetmore, Alexander
1937. Bird Remains from Cave Deposits on Great Exuma Island in the Bahamas. Bulletin Mus. Comp. Zoöl., **80**, pp. 427–441, 16 text figures, 1 plate.

EXPLANATION OF PLATES

PLATE 1

PLATE 1

Fig. 1. *Cerion felis* Pils. and Van. 5 x.
Fig. 2–4. *Cerion felis* Pils. and Van. 2 x.
Fig. 5. *Cerion russelli* Clench. 2 x. Paratype.
Fig. 6. *Cerion russelli* Clench. 2 x. Holotype.
Fig. 7–8. *Cerion russelli* Clench. 2 x. Paratype.

1

2

5

6

3

4

7

8

PLATE 2

PLATE 2

Fig. 1. *Opisthosiphon bahamense insulae-felis* Clench, Holotype. 8 x.
Fig. 2. *Cerion liliorum* Clench. Paratype. 2 x.
Fig. 3. *Cerion liliorum* Clench. Holotype. 2 x.
Fig. 4. *Cerion liliorum* Clench. Paratype. 2 x.
Fig. 5. *Chondropoma canescens* (Pfr.). Winding Bay 3 x.
Fig. 6. *Byssanodonta bahamensis* Clench. Holotype. 9 x.
Fig. 7. *Opisthosiphon bahamense insulae-felis* Clench. Holotype. 3 x.

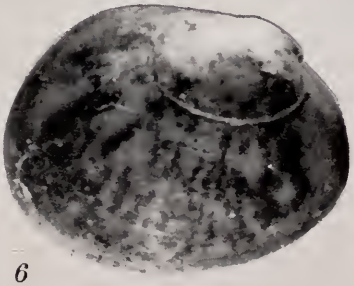
1

2

3

4

5



6

7

PLATE 3

PLATE 3

Fig. 1. *Cerion huntingtoni* Clench. Paratype. 2 x.
Fig. 2. *Cerion huntingtoni* Clench. Holotype. 2 x.
Fig. 3. *Cerion huntingtoni* Clench. Paratype. 2 x.
Fig. 4. *Cerion eximium* (Maynard). Arthurs Town. 2 x.
Fig. 5. *Cerion eximium* (Maynard). 3 mi. S. of North East Point. 2 x.
Fig. 6. *Cerion eximium* (Maynard). North End Point. 2 x.
Fig. 7. *Cerion eximium* (Maynard). Nichols Land. 2 x.
Fig. 8. *Cerion eximium* (Maynard). Cat Island. Paratype. 2 x.

1
2
3
4
5
6
7
8

7575
25

Date Due

OCT 2 8 1996

SEP 3 0 2000

ALME
BOOKBINDING CO., INC.
NOV 2 9 1983
100 CAMBRIDGE STREET
CHARLESTOWN, MASS.

Harvard MCZ Library
3 2044 066 303 538